AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

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THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

I.

The principal shops of the Pennsylvania Railroad for the repair and construction of cars and locomotives, as most of our readers know, are located at Altoona, and, as many of them are also aware, this place is a sort of mechanical Mecca to which many pilgramages are made, by those who are in pursuit of information or enlightenment on the many abstruse problems relating to the mechanical engineering of railroads. A visit to this place is therefore always interesting, and it is hoped that some notes and observations of a recent ramble, through the great works which are established there will be interesting and may be profitable to our readers.

For the following facts regarding the location of Altoona and its surroundings, we are indebted to an illustrated "historical descriptive and statistical" volume published by its Board of Trade.

"The city of Altoona was laid out in 1849 and the Pennsylvania Railroad commenced the construction of its shops in 1850. It is situated about thirty miles southwest of the geographical center of the great State of Pennsylvania, just at the eastern base of the Allegheny Mountains, near the headwaters of the Juniata River—the 'Blue Juniata' of Indian legend and pale-faced song, and on the line of the Pennsylvania Railroad. It lies in the upper or western end of Logan Valley or 'Tuckahoe,' as the vicinity was called in early days, in the central part of Logan township, in Blair County. By rail it is 117 miles east of Pittsburg and 235 west of Philadelphia, although an air line would be one-fourth to one-third less. Baltimore and Washington are 150 miles southeast and Buffalo 200 miles directly north, but by rail the distance to these points is nearly twice as great.

"Originally laid out in a narrow valley, it has filled this and climbed the hills on either side and grown in all directions, so that a large part of it is built on hills of moderate elevation. The city lines, as now established, embrace a territory two and one-fourth miles wide, but it is built up as a city a distance of four miles long and two miles wide. Less than 50 years old, it has grown with such surprising rapidity that it now contains a population of over 40,000 and is now the eighth city in the state in population, and second to none in material prosperity.

"The lowest ground in the city is 1,120 feet above the level of the ocean, and the hills rise 100 to 150 feet higher, making the site and surroundings picturesque in the extreme. . . .

"The railroad passes through the heart of the city from northeast to southwest. . . . In the central part of the city, on the lower ground, are located the railroad company's machine and locomotive shops, freight warehouse, passenger station and an immense hotel, around which the business of the city clusters, this being the 'hub'; although the ever-increasing business of the road has necessitated the building of additional shops at two other places in the eastern suburbs."

The "car shops" are located about a half mile east of the locomotive shops and the "Juniata shops," which have been built within a few years for the construction of locomotives, are about a mile east of the car shops.

Elsewhere plans showing the location of each of these three groups of shops are given, and also a view of the yard taken from the west end of it, adjoining the repair shop, and which shows part of one of the engine houses, and of other buildings, and the network of tracks at that point. Another view of the car shops and the grounds adjoining will give an excellent idea of the appearance of that locality and still another one of the "Juniata shops taken from the north looking southward shows their appearance and that of their environment. The plans represent the shops and grounds, as maps ordinarily do, that is the person looking at them is supposed to be on the south side. As visitors nearly always approach the shops from the north side and as the perspective view of the Juniata shops is taken from the north the plans may at first be a little confusing.

The main or "locomotive shops" as they are called, are the oldest and most extensive and are devoted chiefly to the repair of locomotives, although also some new construction work is done there. The following are the principal buildings and their dimensions:

Middle division round house	235 feet diameter
Erecting shop No. 1	413 feet by 66 feet
Machine shop (two stories)	352 " 63 "
Erecting shop No. 2	414 " 66 "
Office store room, laboratory and test room (three stories)	170 " 40 "
Boiler house	66 " 43 "
Flue shop	125 " 40 "
Boiler and blacksmith shop	192 feet diameter
Blacksmith shop	249 feet by 56 feet
Wheel shop	249 " 66 "
Boiler flange and tank shop	124 " 66 "
Wheel annealing pits	95 " 58 "
Pittsburg division round house	300 feet diameter
Iron foundry	245 feet by 96 feet
Wheel foundry	137 " 70 "
Core room, pattern shop on second floor	80 " 71 "
Brass foundry	78 " 55 "
Pattern store room (two stories)	98 " 48 "
Oil house	57 " 47 "
Wheel foundry	163 " 63 "
Total floor area	367,314 square feet

The car shops, as their name implies, are devoted chiefly to the construction and repair of cars, but a group of small buildings are devoted to work for the maintenance of way. The following are the principal buildings and their dimensions:

Passenger car paint shop	420 feet by 132 feet
Electric transfer table and pit	397 " " 60 "
Group of maintenance of way buildings	19,142 square feet
Freight car paint shop	392 feet by 108 feet
Freight car truck shop	82 " 70 "
Planing mill	356 " 74 "
Blacksmith shop	357 " 73 "
Machine and cabinet shop	303 " 73 "
Upholstering and trimming shop (two stories)	363 " 73 "
Passenger car erecting shop	213 " 133 "
Office and storeroom (two stories)	79 " 39 "
Freight car shop	433 feet diameter
Steam turntable	100 " "
Lumber drying kilns	3,343 square feet
Fire apparatus	53 feet by 33 feet
Total floor area	368,680 square feet

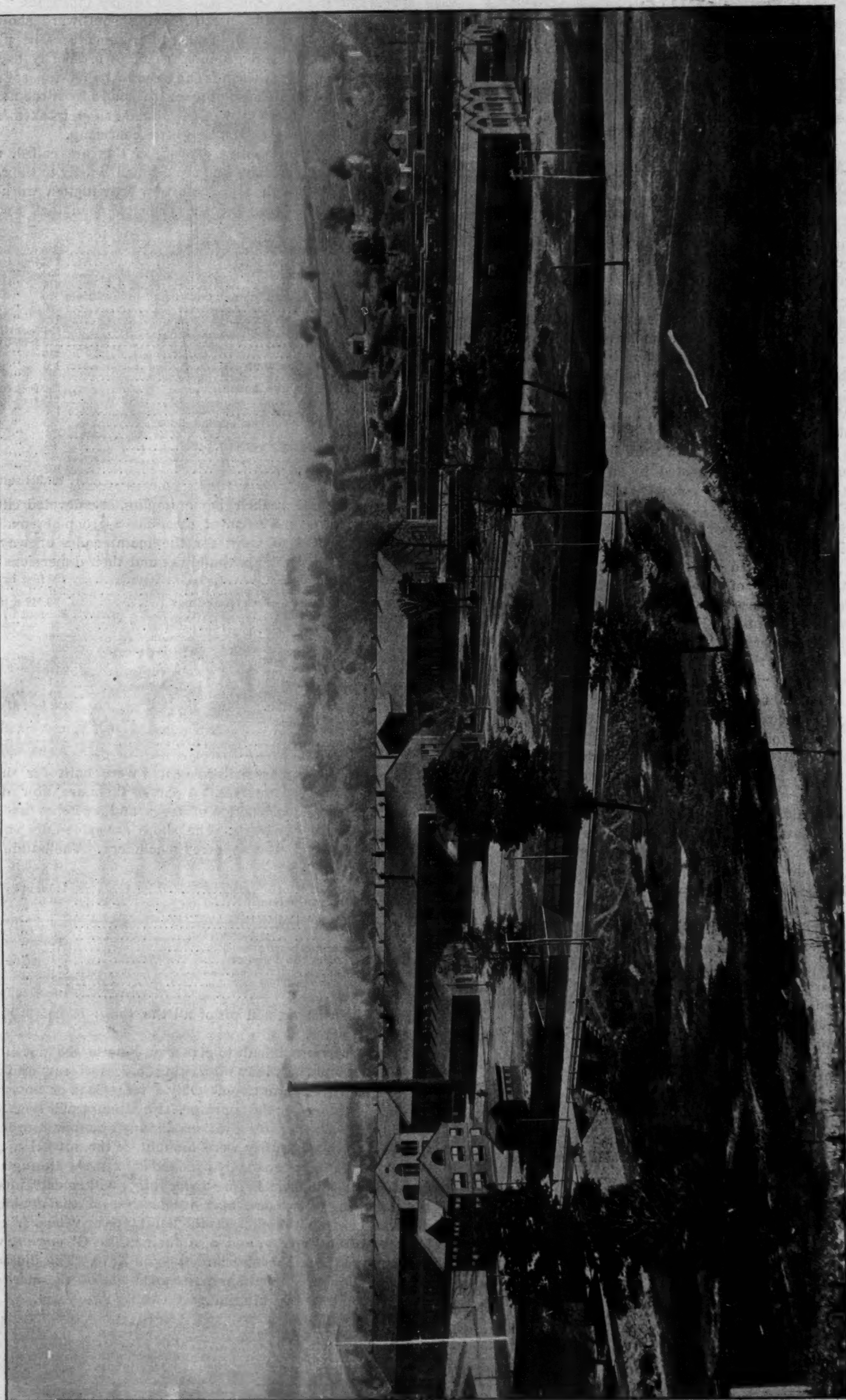
The Juniata shops are the newest and were built for the construction of new locomotives. A part of them are now devoted to the repair and construction of frogs and switches and other maintenance of way work. The shops are splendidly equipped with the latest and most approved machinery. The buildings are as follows:

Paint shop	146 feet by 67 feet
Electric and hydraulic house	60 " 45 "
Boiler shop	386 " 80 "
Blacksmith shop	306 " 80 "
Boiler house	70 " 43 "
Office and storeroom (two stores)	71 " 51 "
Hydraulic transfer table and pit	261 " 60 "
Erecting shop	351 " 70 "
Machine shop (two stories)	258 " 75 "
Total floor area	118,986 square feet.

The entire area of the floors of all the shops is 854,980 square feet or 19.7 acres.

It would be very difficult to give a systematic account of all of these shops, and the many interesting processes and appliances which are carried on in them. Only a large book or many chapters would suffice for that purpose. No attempt will therefore be made to arrange our observations in any systematic order, but they will be noted as they were brought to the attention of the writer during a "personally conducted" ramble through these great establishments. Before doing this it will be explained that the engraving of two passenger locomotives on the double page illustration herewith represents the latest type or "Class L" engine built by this company, and also their "Class G" engine, which was built and was the standard type in 1873. The illustration and the following dimensions give a good idea of the increase in size of locomotives within the past twenty-two years.

	Class G.	Class L.
Diameter of driving wheels	56 inches	80 inches
Cylinders	15 by 22 inches	18½ by 26 inches
Weight	65,200 pounds	134,500 pounds
Pressure in boilers	125 pounds	185 pounds



JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD, ALTOONA, PA.

View of West End of Pennsylvania Yard, Altoona, Pa.

Car Shops of the Pennsylvaria Railroad Altoona Pa.

We will have more to say about the "Class L" engine in a future article.

The Pennsylvania Railroad Company for many years past has made many of the cast-iron wheels used on its road. In connection with the locomotive shops is a well-equipped wheel foundry where large numbers of wheels are and have been made. Great pains have been taken and much skill exercised to procure the best possible materials for their manufacture, and to produce the strongest, safest and most durable wheels of that kind. Recently an expensive accident occurred on the road while a train was coming down the long and steep grade west of Altoona. The accident was caused by a broken wheel under a foreign car, the failure of which was attributed to the action of the brakeshoes, which were applied in descending the grade, and which heated the wheel, and it was thought thus cracked it. To throw some light on the subject, it was decided to make tests of wheels made by different manufacturers, to determine the effect of heating the tread. To do this the wheels were placed in a sand mould flatwise, with their flanges down and their axes vertical. Around the tread of the wheel a circumferential space was left 1½ inches wide measured radially to the wheel, this space being surrounded with sand, the top of the mould being left open. Into this space molten cast-iron was poured, with the result that in many cases some of the ribs or brackets were cracked in about half a minute after the metal was poured, and the plates in about a minute after the molten metal came in contact with the tread. At the time of the writer's visit to the foundry, which is here reported, three new wheels were prepared for such a test; two of them manufactured by a reputable maker, and one of these two wheels was taken from those supplied by the manufacturer in the regular course of trade, and the other a special wheel furnished for the test, and said by the maker to be the best he could produce. The third was a new wheel made in the Altoona foundry. In one of the tests the molten iron was poured into the space around the tread of the wheel first described, so as to nearly fill it up to the edge of the rim. In forty seconds after the pouring ceased there was a sharp click indicating that one of the brackets was cracked, and in forty-five seconds the upper plate cracked with a report like that of a small pistol. The crack was a radial one through the rim, and it then extended circumferentially just inside the rim about one-sixth of the way around the hub. The second wheel, which was said by the maker to be the best that he could produce, cracked in the same way in the plate in two minutes after the iron was poured, the fractures being of somewhat less extent than the first. The Altoona wheel was then tested, but did not break when the melted iron poured around it had become black by cooling. Other tests have been made of wheels which had been in service with similar results. The Altoona wheels are reported to have stood the test in every case excepting one, while a large proportion of those made by manufacturers who sell wheels were broken. During a considerable part of the time after the iron was poured, when the tests which are described above were made, the wheel was so cool that a person could bear his hand in the inside of the rim, and the plate, excepting the portion near to the rim, was so cool during the whole test that a person's hand could be kept in contact with it without pain. A match moved slowly in contact with the plate from the hub toward the rim immediately after the test was not lighted until it was near the rim.

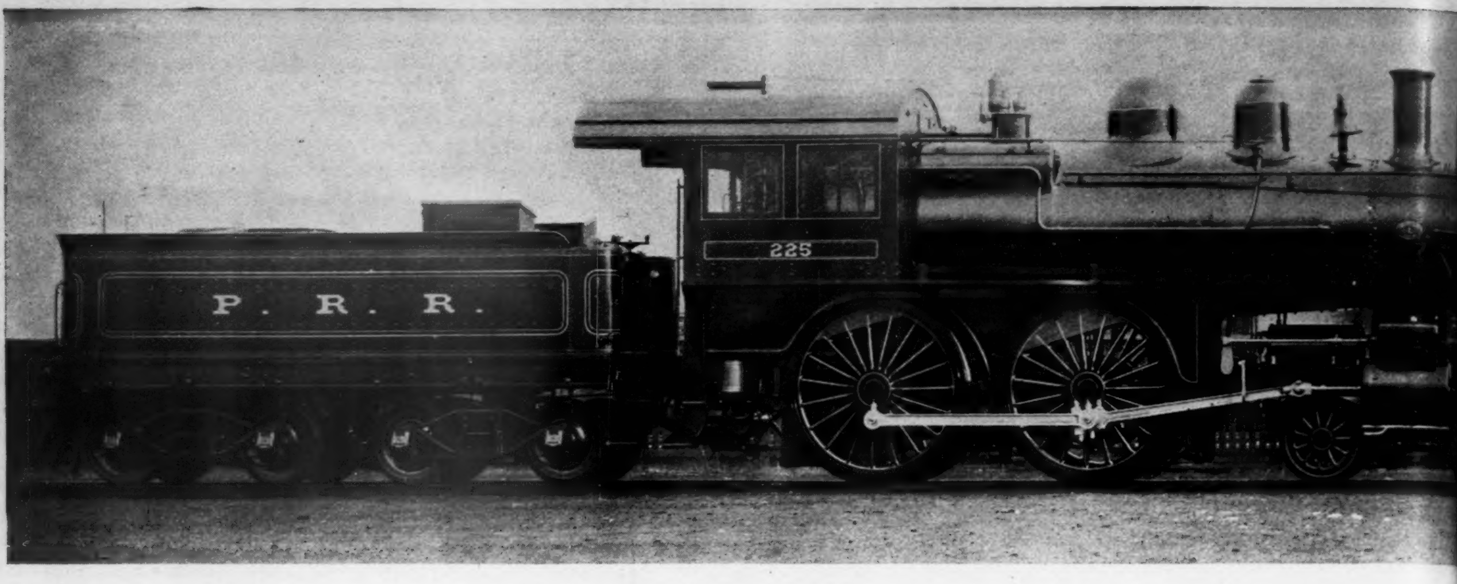
These tests are certainly very remarkable, important and somewhat alarming. If, as was shown, an ordinary cast-iron wheel is liable to break when its rim is heated to a comparatively low temperature, there is certainly very much more danger attending their use on long grades when the brakes must be applied for considerable periods than is generally supposed, and the responsibility for using cheap and inferior wheels is correspondingly great. The forms of the wheels which were tested were all alike and were of the ordinary double plate pattern, with curved ribs on the back, so that the capacity for withstanding the test in the one case and the failure in the other was probably due to the difference in quality of the material of which they were made. It may be that if the wheels made of inferior material had been of a different form they would not have broken, and this kind of tests supplies the means for determining what are the best forms for such wheels. Thus far those adopted appear to have been evolved by rule of thumb methods alone. It may be that the forms which have been used so long are weaker than was ever suspected, and that some other shapes would be much less liable to fracture. The test showed indubitably that heating the treads of the wheels subjected their plates and ribs to tremendous strains, and the only reason why the Altoona wheel did not break was that the material of which it was made had sufficient strength, elasticity, ductility, toughness, or whatever it is called, to resist these strains. It would seem to be the part of wisdom to make wheels, if it be possible, of a form which would not be subject to such strains when their treads are heated, as they were in the tests, or as they would be by the application of brakes. It would be interesting and possibly instructive to put wheels say in a lathe and apply brakes to them with the ordinary maximum pressure and then revolve the wheels at the speed with which they would probably turn in actual service. This would show whether the heating action of the brakeshoes has the same effect as the molten iron produces. This is an attractive field for investigation and one in which more knowledge is urgently needed.

The Altoona wheel foundry is well equipped with hydraulic cranes and other appliances. The wheels are now all made in contracting chill moulds which give a more uniform chill in the treads of the wheel than can be produced in any other way. The materials used for wheels are from 30 to 35 per cent. of charcoal iron, 15 per cent. of coke iron, 5 per cent. of steel and from 50 to 55 per cent. of old wheels. It is specified that the coke iron shall not have more than from 1 to 1.25 per cent. of silicon.

One machine in use in connection with the foundry was new to the writer. This was for brushing the sand from the wheels. It was made by the Northwestern Wheel and Foundry Company, of St. Paul, Minn., and consists of two iron discs of about the same diameter as the wheels, which are each mounted on the ends of horizontal shafts. Each disc overhangs the bearings of its shaft, which has a driving pulley and friction clutch for throwing in and out of gear. The discs face each other, and to the surfaces thus presented wire brushes are attached, and the wire strands project at right angles to the faces of the discs, the wires being parallel to the axis of the shafts. The latter have a certain amount of horizontal movement in their bearings, so that by means of levers the discs can be drawn apart and a wheel rolled between them. The discs are then made to revolve by belts on pulleys attached to the drafts, and the brushes are brought in contact with the two sides of the wheel, and all the sand is thus quickly brushed off from the exposed surfaces. That which adheres between the ribs is afterward brushed out by a cylindrical brush resembling somewhat a large paint brush attached to a flexible shaft driven by a pulley. The cost of cleaning wheels has been reduced three cents per wheel by the use of these machines.

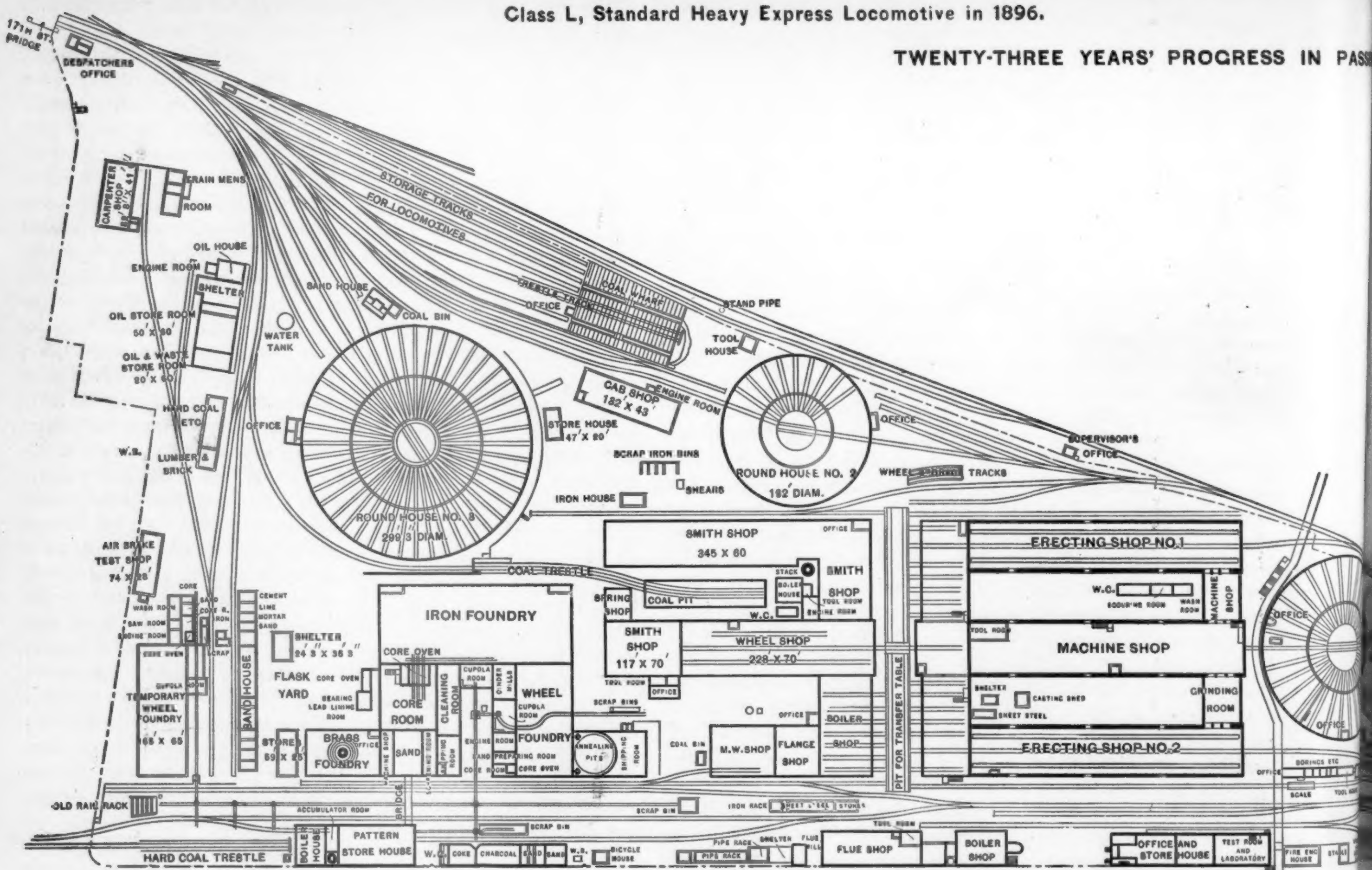
Another interesting machine is a sand sifter made by the Walker Manufacturing Company, of Cleveland, O. This consists of a rectangular box, about 3 by 5 ft. and a foot or 18 inches high or deep, and with a sieve forming the bottom. This box is suspended by inclined, loose-jointed links or rods about 2 feet long attached at each of the four corners. Over the middle of the box is a bearing which receives the pin of a crank attached to a vertical shaft over it and driven by a pulley or belt. As the crank revolves the bearing is of course carried in the path of its pin and the box is carried with it. The latter being suspended by the inclined links the horizontal oscillation of the lower ends of the latter causes the corners of the box to rise and fall in sequence, as it were, which with, the movement imparted by the crank, produces a sort of squirming or wriggling movement admirably adapted for sifting the sand which is put into the box.

The brass foundry is also an interesting place and is well arranged and designed. The building is 36 by 80 feet, with a central stack, or chimney, and with 18 furnaces arranged circularly around it. This building is admirably lighted and well ventilated, and has capacity for melting ten tons of metal per day. An adjoining room contains appliances for lining car journal bearings with lead. The bearing surfaces of these are first cleaned with

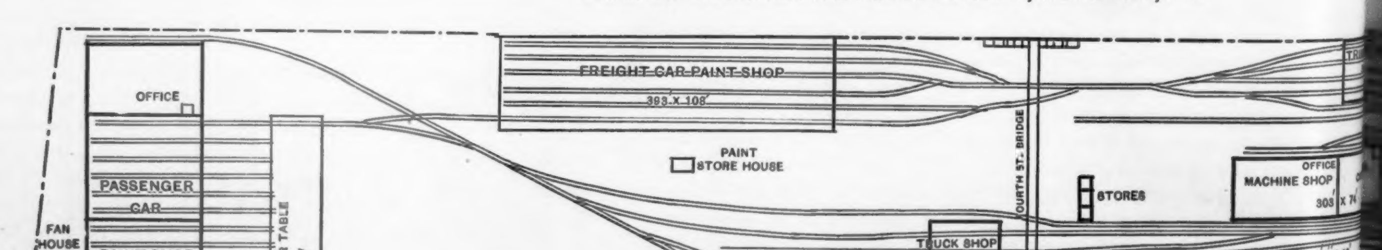


Class L, Standard Heavy Express Locomotive in 1896.

TWENTY-THREE YEARS' PROGRESS IN PASS



PLAN OF LOCOMOTIVE REPAIR SHOPS, ALTOONA, PA.



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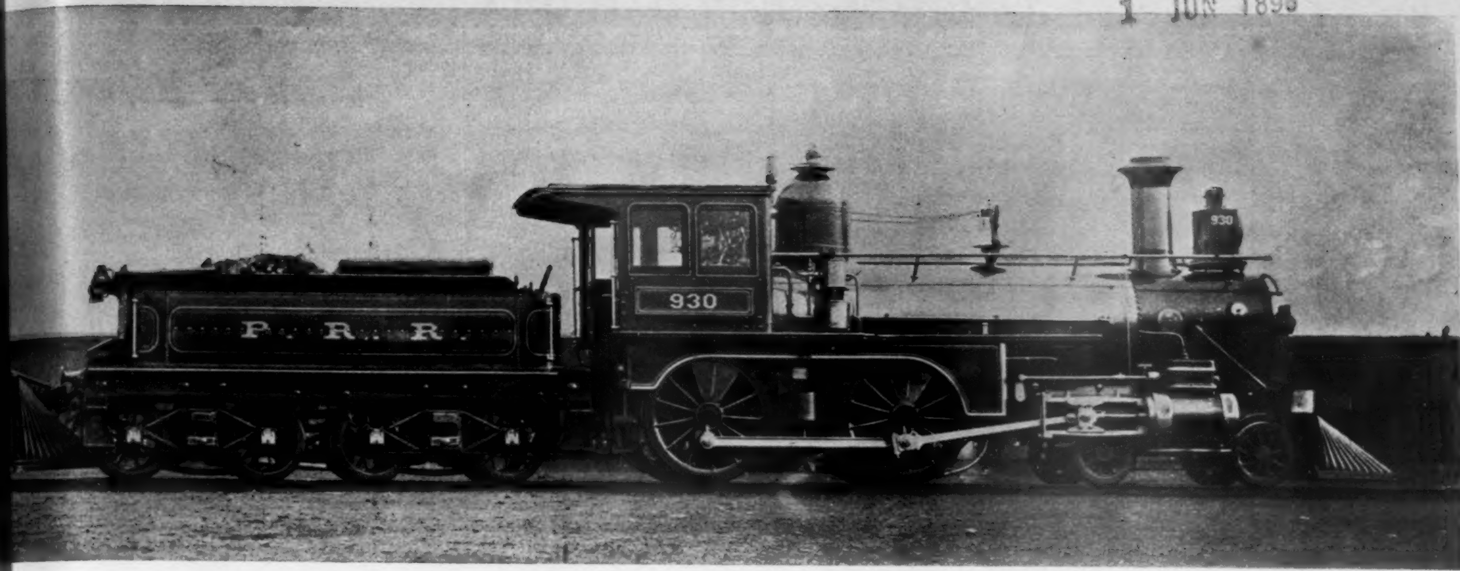
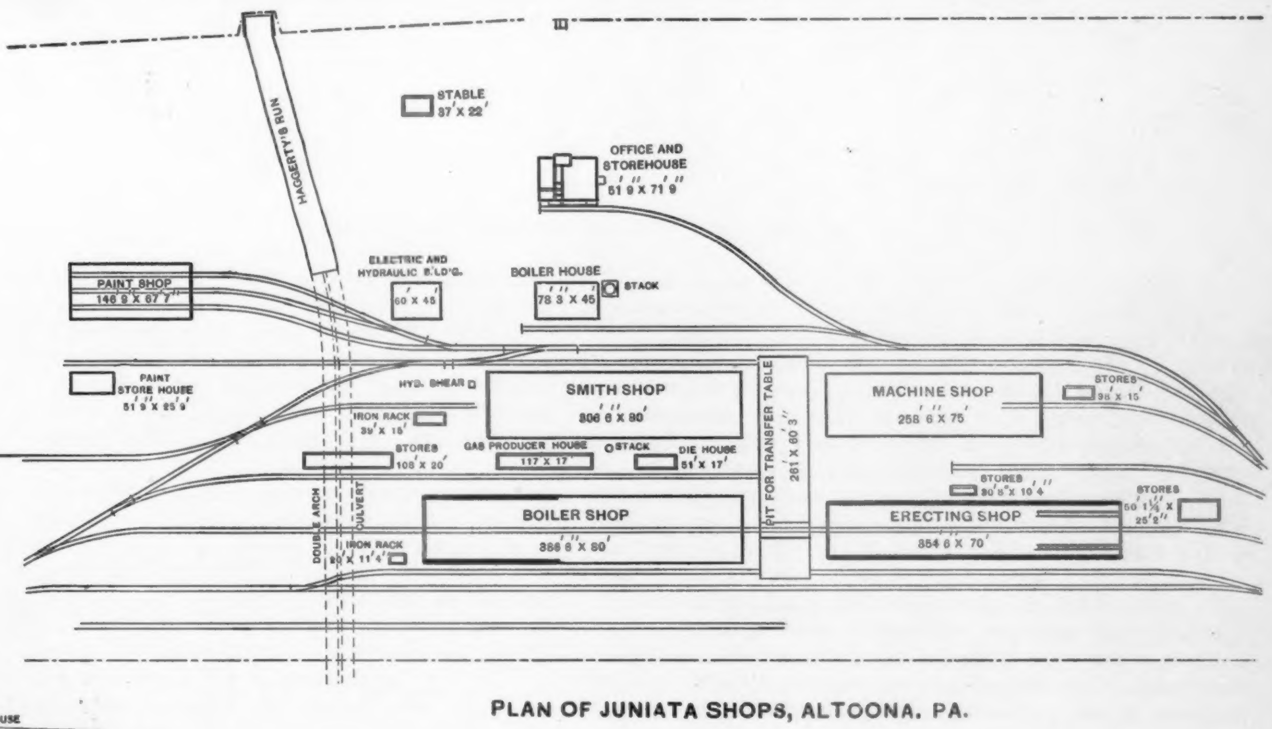
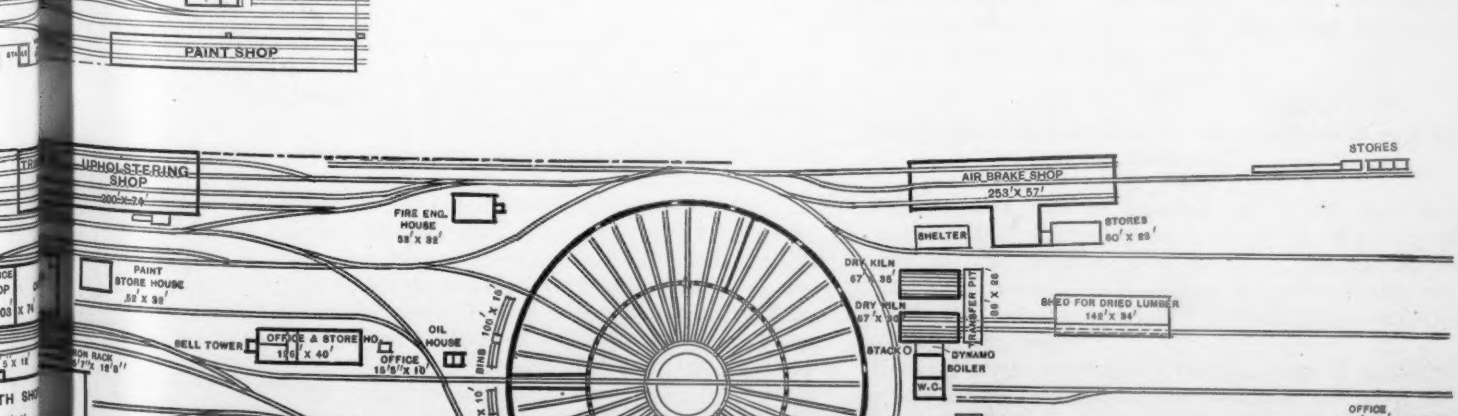


Class G, Standard Passenger Locomotive in 1873.

PASS ENGINE CONSTRUCTION ON THE PENNSYLVANIA RAILROAD.



PLAN OF JUNIATA SHOPS, ALTOONA, PA.



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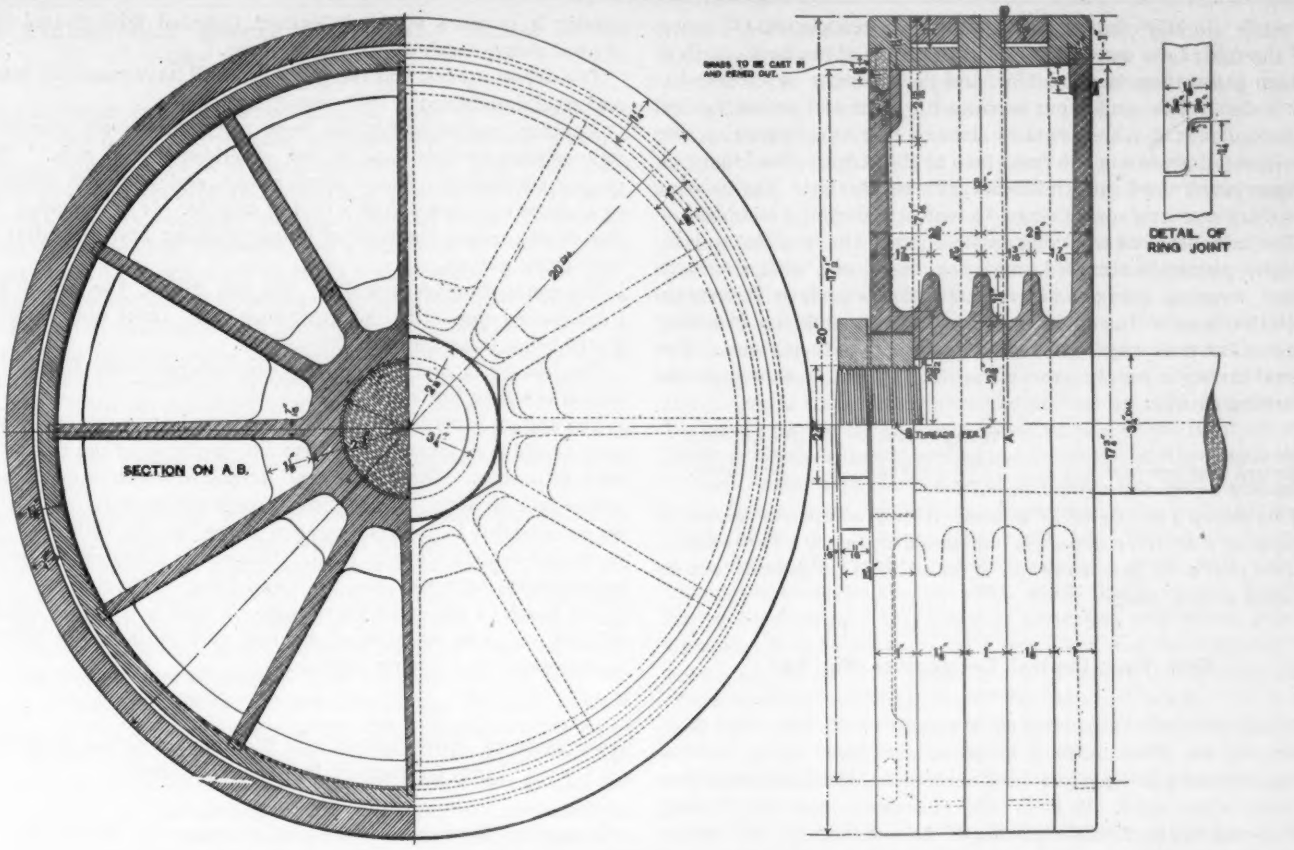


Malleable Iron Piston—Norfolk & Western Railroad.

dilute acid, and are then tinned. After this operation they are clamped against a vertical cylindrical iron "core"—it may be called—having projections which leave a space of about one-eighth of an inch between it and the brass into which the melted lead is poured. As soon as the lead is set the fin, or superfluous metal, which projects is cut off by a kind of shear attached to the core. The whole process is quickly done. This lead lining is generally used on bearings for the Pennsylvania road.

In the use of brass bearings it was found that what may be called hard nodules were formed in the metal, which were not worn away with the other metal, but would often project from the surface and wear into and cut the journals. The formation of these nodules was finally attributed to oxidation on the surface of the melted brass while it was in the crucibles. A cure for the evil was found in sprinkling powdered charcoal over the surface of the molten metal while it is in the furnace.

An interesting annex to the foundry is the boiler room. In this three large Bellpaire boilers of the locomotive type have been installed, with room for an additional one. The level of the engine-room is about five feet below a track which extends into it and is supported on posts or trestle work. The track runs transversely to the boilers and is about eight or ten feet back of them—speaking in locomotive parlance. The coal is brought in on drop bottom cars and dumped on this trestle. It is then within convenient distance for firing the boilers, and is placed in that position without any other labor than that of running the cars in and dumping them. In front of the fireboxes of the boilers is a transverse pit, or what might be called a ditch, which has a bucket, which runs on a track on the bottom of the pit. This bucket can be placed in front of the ashpan of any of the boilers and the ashes can be raked directly into it. Between two of the boilers is a lift which consists of an inclined runway extending from the ashpit backward over the track on which the coal is brought in. This runway has a wire rope operated by a horizontal cylinder and pulley under the roof. To remove the ashes, a car is run in on the track to receive them, and the bucket is then filled and brought to the foot of the runway, the wire rope is attached to it, water is admitted to the cylinder; the bucket, which has a drop-bottom, is carried up and over the car, when it is dumped and the ashes deposited in it without any other labor than is here described. The hydraulic cylinder and piston is operated by a pump and accumulator in the usual way. Adjoining the boiler room there is also a Clayton air compressor which supplies air to various appliances inside and outside the foundry. One of them is an air lift or hoist for loading and unloading cars. This consists of two posts about twenty feet high and placed about thirty feet apart with a transverse beam on top, to which a vertical cylinder with about ten-feet stroke and perhaps twelve inches diameter. The piston rod can readily be attached to any object which is thus raised by the admission of air to the cylinder.

A steel rail breaker is also an appendage to the foundry. This consists of a large hydraulic cylinder, somewhat like those used for hydraulic riveting machines, the piston of which works horizontally. The rail is placed between the ram and suitable bearings, and when water pressure is admitted the rail is broken almost like a pipe stem. The rails are reduced to short pieces to facilitate putting them in the cupola when they are mixed with the iron for the manufacture of wheels.

(To be Continued.)

Malleable Iron Locomotive Piston.—Norfolk & Western Railroad.

The Norfolk & Western Railroad has recently put into service a number of locomotive pistons, in which the head is of malleable iron, with an outer rim of cast iron. Through the courtesy of Mr. R. H. Soule, Superintendent of motive power, we have received the working drawings from which the accompanying engravings were made.

The head proper consists of a single casting of malleable iron, having a central hub 4$\frac{3}{4}$ inches in diameter, and front and back plates or walls ranging from $\frac{5}{8}$ to $\frac{11}{16}$ inches thick. Twelve radial ribs, from $\frac{5}{16}$ to $\frac{7}{16}$ inches thick, extend from the hub outward and three circular ribs strengthen the hub. The casting resembles the ordinary "solid" piston except that it is open at the rim. This opening is closed by a cast-iron ring 1$\frac{1}{4}$ inches thick, and the full width of the piston head, namely, 5$\frac{1}{4}$ inches. The fit for this ring

is made slightly conical, being, on this 20-inch piston, 17½ inches at the front face and 17¾ inches at the front of the back wall, at which point there is a shoulder, and the diameter is enlarged to 18 inches. The ring is put on from the front and forced against this shoulder; it is then held in place by casting a brass ring into the dovetail groove in the front face of the piston. The brass ring is hammered down until it fills the groove tightly. The packing rings are cast-iron spring rings, 1⅛ inches wide and ⅝ inch deep.

The advantage of this construction lies in the fact that a light-weight piston is obtained, and yet cast-iron, with its unexcelled wearing qualities, is retained for the surface in contact with the bore of the cylinder. The retaining ring for fastening the rim is a neat way of avoiding the use of bolts or rivets. The actual saving in weight over a cast-iron piston is shown in the following figures:

Type of piston.	Weight without packing rings.	Weight with packing rings.
Standard (cast-iron box)	257.5 pounds	280 pounds.
Composite	187.5 "	210 "

This shows a saving of 70 pounds if the composite piston is compared with the company's old standard piston. The officials believe that a further reduction of from 10 to 20 pounds can be effected in this design.

New York Central Locomotive No. 923.

A new anthracite coal burning locomotive has just been completed at the West Albany shops of the New York Central Company and has been put into service on the Hudson River division of the road. It is of the American type with 78-inch wheels and 18½ by 22-inch cylinders. The firebox is 108 inches long, and is placed on top of the frames and has a water-bar grate, which inclines downward toward the front. The springs and equalizing levers are below the driving-boxes, the latter being made of Ajax metal. The crown sheet is slightly arched and is supported with crown bars with a wagon top over them. The firebox rests on expansion links pivotally connected to the frames and to the boiler.

The general design and finish of the engine is similar to the celebrated 999. Nearly all the parts which were susceptible of it are brightly finished and polished, the fixtures in the cab being nickel-plated. Many of the bolt heads, as in the guide bars, smokebox and boiler braces are counter-sunk so as to make a smooth finish. The oil cups on the guide-bars are forged solid with them with tight fitting covers. The cylinder oilers have a self-measuring attachment by which a definite quantity of oil can be applied at each oiling.

The firebox has Mr. Buchanan's furnace door with an inside deflector, which has worked so satisfactorily on this road. As the trailing driving-axle is under the firebox, the ash-pan must be arched over it. It consists of two deep, hopper-shaped receptacles, one in front and the other behind the rear axle, and have sliding doors at the bottom which are operated by a vertical shaft, which extends upward through the foot-plate, and has a lever on its top end. When the doors are opened this must be turned outward and projects over the foot-plate behind the firebox, and is thus in the way of the fireman. When the doors are closed the lever is moved forward and then stands transversely to the engine, close to the firebox, and is then out of the way. The projection of the lever over the foot-plate is thus a reminder to the fireman that the doors are open, the object being to have them always closed when the engine is on the road. An opening is provided in the front of the ash-pan at some distance above the rails for the admission of air.

The tank is provided with a gage on the front end. This consists of a vertical iron pipe connected to the bottom of the tank, and with a cock in the connection. A number of small holes are drilled at close intervals along the whole length of the iron pipe. When the cock is opened water flows out of these holes, and thus shows how high the water is in the tank. The iron pipe has the advantage over a glass gage, that there is no danger of breaking it.

The apron which covers the interval between the foot-plate and tender is covered with sole leather, fastened with rivets, which gives a secure foothold for the fireman.

The driving truck and tender wheels all have cast-iron centers and steel tires fastened with retaining rings.

Another feature which has been very extensively adopted on new engines for this road is the extended piston rods. These project through the front cylinder-head, and are then supported by a guide and inclosed by a casing outside. It is reported that this device lessens the wear of piston packing and cylinders to a very great extent.

The connecting and coupling rods are fluted, the latter have solid bushed ends and the former stub ends, front and back, the straps being fastened with three bolts.

The hand-rails and hand-holds are covered with Russia iron, which is a new device.

The engine is equipped with monitor injectors, chime whistle and Gould's automatic couplers, at the front of the engine and back of tender. The engine and tender are both painted black, with silver striping. Excepting in some of the switching engines, we believe this is the first instance of the use of anthracite coal on the New York Central road. This one is intended for service on the trains between New York and Poughkeepsie.

The finish of the engine surpasses—if that is possible—that of the 999, and is an example of the best and most recent practice in American locomotive engineering.

Admission of Apprentices and Mechanics to the Engineering Courses of Purdue University.

In response to numerous inquiries in regard to the admission of experienced mechanics to the Engineering Courses, the President of Purdue University has published a statement embodying the practice of the University in such cases.

The courses in Mechanical, Civil and Electrical Engineering include lines of work such as carpentry, pattern-making, molding and casting, forging and machine work, with which shop men are often familiar, and for this reason such men may enter these courses under conditions which are greatly in their favor. Thus those who, as apprentices, have acquired skill in manipulation and have become acquainted with the principles of construction, can properly be excused from the shop work which other students are required to take; the experiences of the shop can in this way be made to count in advancing the student in his professional course. Or if it happens that an applicant is unprepared in some line of work required for admission, such deficiency need not prevent his admission, provided his credits in shop work are sufficient to give him time in which to bring up the required preparatory work.

Each application for credit or for conditional admission will necessarily require individual consideration, and persons seeking such admission are advised to inform themselves by correspondence before going to the expense of applying in person. The important conditions, however, governing the admission of persons having credits and conditions are indicated in the following statements:

1. Each applicant for admission who desires credits in shop work must present a statement in his own handwriting setting forth his shop experience, which statement should be indorsed and approved by the superintendent of the shop or shops in which he has worked.

2. Three years' experience as a regular apprentice or as a journeyman in an approved shop will be accepted as a complete equivalent for all shop work required by the college course. It is equivalent to a credit of nine hours per week for two years. An experience of less than three years may be accepted as an equivalent for a portion of the shop work required in the course.

3. Applicants for admission who can show that they are entitled to credits in shop work, but who are unable to pass entrance examinations, will be admitted conditionally if their general attainments indicate that they are likely to become successful students; but such applicants should not be less than twenty years of age.

4. Students admitted as freshmen, with credits in one or more lines of college work and with conditions in preparatory subjects, will be given regular instruction in the subjects in which they are deficient.

5. Students admitted with conditions will be required to pursue such lines of study in some one of the three courses named as will tend to make them regular. Special courses of selected studies will not be granted.

The Pennsylvania Avenue Subway and Tunnel in the City of Philadelphia.

The abolishment of grade crossings in large cities presents to the engineer many complicated problems for solution and involves the expenditure of millions of dollars. In some cases easy grades on the streets and the railroads, the minimum damage to adjacent property, economy in expenditure and a non-interruption of traffic are the chief problems, and even then the work is not an easy task. But when the railroad tracks whose grades are to be altered are connected by sidings to numerous manufacturing and industrial establishments, warehouses and elevators, and as a result of the improvements are found to interfere with existing water, gas and sewerage systems, the difficulties are vastly increased. Such is the situation which the engineers in charge have had to meet in preparing the plans for the new subway and tunnel for the Philadelphia & Reading Railroad in the city of Philadelphia.

Several years ago the railroad company completed its handsome terminal station, and the elevated approach to it, by which a number of dangerous grade crossings were avoided. But leading from these terminal tracks is a line running at grade through Pennsylvania avenue and crossing many streets. On each side of it are large industrial establishments, some of them of worldwide reputation, and all doing a large business, such as Wm. Sellers & Company, Baldwin Locomotive Works, Bement, Miles & Company, Whitney & Sons, and others. The constant switching of cars made the location so dangerous that finally the city authorities and railroad company mutually agreed to lower the tracks, the cost of the work to be shared equally by the two corporations. Accordingly an ordinance was passed by the City Council in March, 1894, accepted by the railroad company, and the work of preparing the plans placed in charge of the city's engineering department. The estimated cost of the work is $6,000,000, and upon its completion seventeen grade crossings will be abolished and the entrances to Fairmount Park relieved of objectionable features.

These plans are now complete, and such changes as were necessary in the sewage system of the city have already been made. During the past month the city has been receiving bids from contractors, and the work will be given out at an early date and construction pushed rapidly. The tracks will be lowered on the average 25 feet below the surface of the streets, and the total length of the right of way, the grade of which is altered, is 10,000 feet, of which 2,912 feet is tunnel, 6,028 feet is open subway, and the remaining 1,060 feet is elevated structure. Besides the sidings leading to industrial establishments, there are two freight yards adjacent to the main tracks which must also be depressed, one between Thirteenth and Sixteenth streets and the other at Twentieth street, where an engine house, coaling station and turntable are also located. The open subway is wide enough for from four to six tracks, and the tunnel is to contain four tracks. It is evident, therefore, that the work is one of great magnitude.

On page 96 we have reproduced a perspective of the work as it will appear when finished, and on this view is designated the location of a number of important manufacturing plants, most of them well known to our readers. On page 97 is given a plan of the subway and tunnel, with sections of both, and Figures 3 and 4 on page 99 give additional sections that are of interest.

The plans provide for a very slight change of grade at Twelfth street, the railroad being carried over it as at present. Beginning at Twelfth street the tracks continue on a down grade of 2¼ per cent. to a point just beyond Broad street, where the grade is eased off to .8 per cent., which continues for about one and one-half blocks, after which the tracks are practically level to the portal of the tunnel. At Thirteenth street the tracks will cross at about the present grade of the street, requiring the latter to be depressed considerably, but this is the only street whose grade is changed materially. From Thirteenth to Sixteenth streets the entire space between the north side of Callowhill street and the north side of Pennsylvania avenue is to be excavated to form a depressed freight yard for the railroad company. All streets from and including Broad street to Twenty-first street are to be carried over the subway on bridges. This portion of the work to the portal of the tunnel presents the greatest difficulties, because of the numerous sidings and the fact that the retaining walls will come so close to the building lines as to require the underpinning of many buildings and the reconstruction of their foundations. Fortunately it has been found possible to reach all sidings which must be kept open by means of temporary tracks that will be laid through Hamilton street east from Pennsylvania avenue, thus leaving the contractors comparatively free to carry on this section of the work.

The connection to Baldwin Locomotive Works, near Broad street, and the warehouse across the way, near Sixteenth street, are each to be made by a five per cent. grade. Near Sixteenth street several tracks cross over the subway on a bridge, thus allowing an engine to place cars on either side of the right of way. Between Seventeenth and Eighteenth streets another connection is made to the Baldwin Locomotive Works, the maximum grade being five per cent., as before. These grades are indicated in the profile of Fig. 2. Between Nineteenth and Twentieth streets a grain elevator is reached by a four per cent. grade, and west of Twenty-first street a five per cent. grade leads to the Knickerbocker Ice Company's building. Connection to Bement, Miles & Company is to be made on the lower level, and the company will have a lift on its own property. The necessity for such steep grades leading to sidings arises from the short blocks. It is evident that each of these inclines must rise from the subway to the surface in less than the length of a block, and, as the blocks average considerably less than 500 feet long, the grades must be heavy.

Between Sixteenth and Eighteenth streets the firms of Wm. Sellers & Company and A. Whitney & Sons each have track connections, and to reach these parties a hydraulic lift is to be placed on the south side of the subway. It is seen in the perspective view, partly raised, and is also designated in Fig. 2 close to the Eighteenth street bridge. This lift is to be an immense affair, 155 feet long, and capable of carrying a locomotive and three loaded cars, making a total load of 320 tons, to be raised 26 feet. The great length of the table, and the fact that the load may be concentrated at almost any point on it, make the construction of this lift a very neat problem. The specifications for it do not impose any restrictions on bidders other than those inherent in the problem, the engineers in charge wisely concluding that these in themselves were difficult enough.

A commercial coal conveyor is to be located near Fifteenth street, and a power house south of the tracks between Eighteenth and Nineteenth streets will furnish hydraulic and electric power and light at various points along the subway and tunnel.

The triangular yard between Twentieth street, Hamilton street and Pennsylvania avenue, now occupied by the railroad company, is to be excavated, and will contain an engine house, a small repair shop, a coaling station with conveyors for ashes and coal, a freight house with hydraulic lifts, a 65-foot turntable and a 50-ton electric traveling crane of 43 feet 10 inches span, serving two tracks and capable of unloading direct from the cars to a roadway on the street level. Altogether quite a large and interesting plant is installed in this depressed space.

The tunnel begins just west of the above-mentioned yard. It consists of a single span of 52 feet, with a rise of 8 feet 8 inches, and is to contain four tracks. The arch is of brick and the tunnel is one of the widest of its kind. Its length is 2,912 feet, and a considerable portion of it parallels the two-track Baltimore & Ohio Railroad tunnel. The western portals of the two tunnels are in close proximity. A section of the tunnel is given in Fig. 2, and Fig. 3 is a section through the two tunnels, showing their relation to each other and also giving an idea of the ventilating arrangement for the new tunnel. Owing to the heavy traffic contemplated and the large dimensions of the tunnels, an elaborate system of ventilation has been provided with exhaust fans and fresh air intakes. West of the tunnel the tracks will be carried in an open subway on an ascending grade of 1.3 per cent. to the present level of the track at Thirtieth street. Footway bridges will be

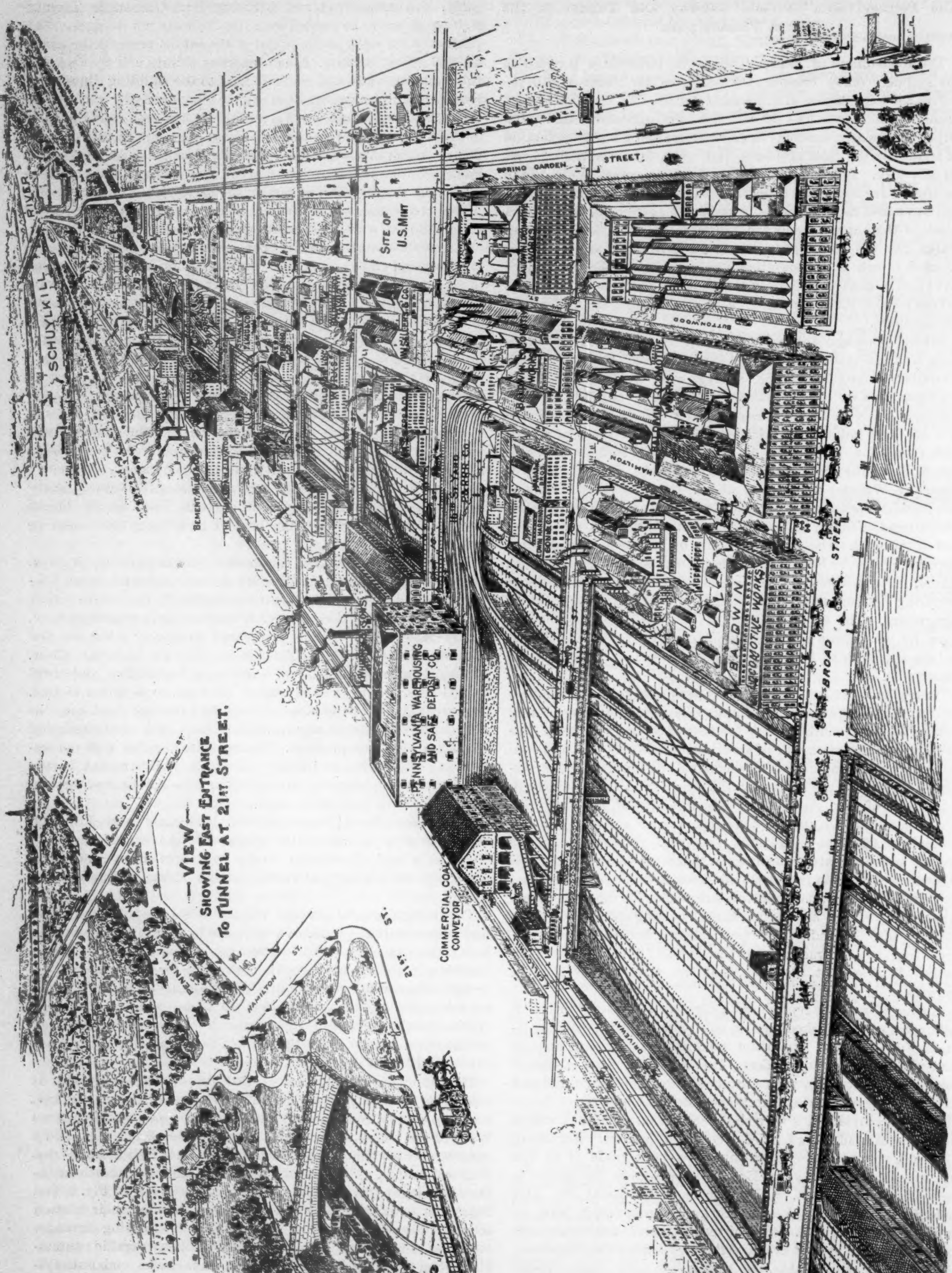


FIG. 1.—PERSPECTIVE VIEW, SHOWING PENNSYLVANIA AVENUE SUBWAY AND TUNNEL AS IT WILL APPEAR WHEN COMPLETED

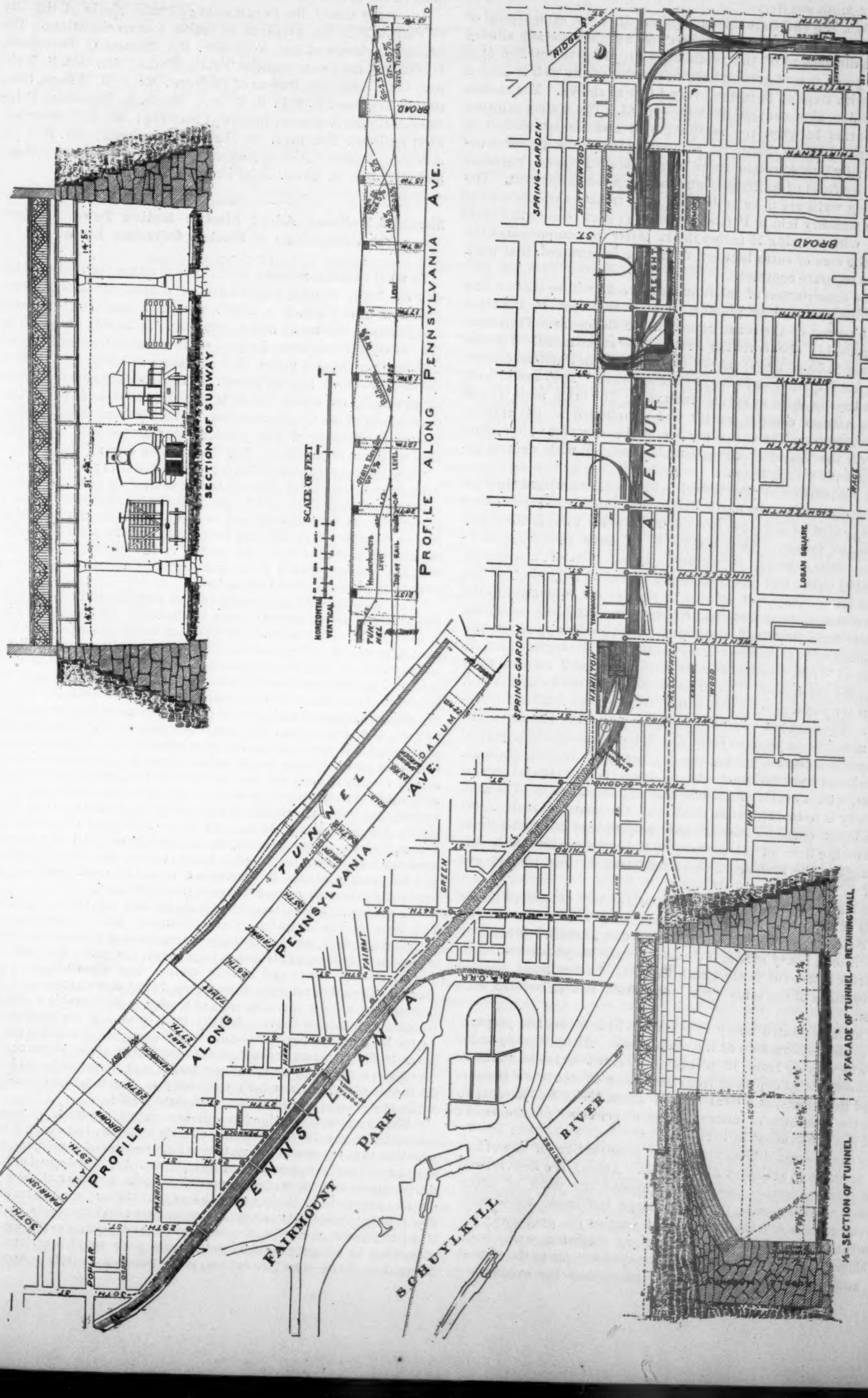


FIG. 2. PLAN, PROFILE AND SECTIONS OF PENNSYLVANIA SUBWAY AND TUNNEL.

carried over the subway at Twenty-seventh, Twenty-eighth and Twenty-ninth streets.

In Figs. 2, 3 and 4 are given sections that are each typical of the masonry work. The tunnel section we have already alluded to; the dimensions of the retaining walls are given in Fig. 4; if at any point it is of greater height than shown the wall is carried down with steps of 18 inches every 4 feet as shown. The section of a bridge abutment is likewise typical. The section showing the relation between the retaining wall and the foundation of adjacent buildings that must be under-pinned during construction is only one selection from many cases. In some instances the entire front of buildings must be removed and rebuilt. The retaining walls are to be built in an open trench, and are to be of rubble masonry laid in Portland cement (1 part cement to 3 parts sand), with a coping 10 inches thick. After the completion of the walls the core of earth between them will be removed, that work being a separate contract.

In the construction of the tunnel the tracks will be thrown first to the one side of their present location and then to the other side, to permit of the construction of the side walls. Then after the removal of the core the arch will be constructed. The side walls are to be of large rubble masonry laid in Portland cement of the same quality as for the retaining walls. They are to have refuge bays in them at regular intervals. The brick arch is to be laid in natural cement mortar and terminated at the ends by stone voussoirs. The entire surface of the extrados of the arch and over the spandrel filling is to be plastered with natural cement mortar ½ inch thick.

The ventillation of the tunnel will be accomplished through two fan stations on the north side of the tunnel, one located near Twenty-third street and the other between Twenty-fifth and Fairmount avenue. Each station is to have two large slow-moving fans, driven by electric motors, each of a capacity of 150,000 cubic feet per minute, or a total of 600,000 cubic feet for the four. They will be able to remove air equivalent to the total volume of the tunnel every five minutes. Into these fan houses conduits enter from both directions. Each has four openings into the tunnel of 35 square feet area, and the conduits begin with a diameter of 6 feet 6 inches at their further ends and increase to 11 feet at the fan houses. One of these is seen in the section in Fig. 3. On the south side of the tunnel ten fresh-air intakes are provided. They are not located directly opposite the exhaust openings, as might be inferred from Fig. 3, but at intermediate points. The openings for the intakes are covered with cast-iron gratings. The exhaust conduits are to be of brick laid in natural cement mortar, with a cradle of rubble masonry or concrete. The arch generally is to be 13½ inches thick and the invert 4 inches. At the exhaust openings they are to be bonded into the brick tunnel arch and the lines of intersection of the cylinders formed by the opening and the arch are to be constructed of fine pointed cut stone.

The highway bridges built over the subway at various points are all of the plate girder deck type, with solid floors covered with concrete, on which is laid 3 inches of asphalt. Where the street is on a heavy grade, the roadway is to be paved with vitrified brick instead of finished with asphalt. The railroad bridges are also to be of the same type, with solid floors, covered with ballast.

As already stated many new sewers had to be laid preparatory to the construction of the main work. Altogether 3½ miles of sewer varying from 12 inches to 10 feet 6 inches in diameter have been laid at depths of from 20 feet to 40 feet below the surface of the streets, at a total cost of about $500,000. In order to cause the minimum of inconvenience 65 per cent. of the sewer work was constructed in tunnel.

The engineering difficulties in the construction of a work of such magnitude are many and various. Among the most serious in the present instance may be mentioned the work of under pinning, and supporting the many large buildings, warehouses and elevators while the excavation is carried on practically beneath the foundations, and the masonry retaining walls built. The blasting of the rock near such structures requires the utmost care and good judgment. Special machinery for excavating will be required, and water and gas pipes and electrical conduits must be taken care of.

As already stated, the Department of Public Works of the City of Philadelphia has prepared all plans and specifications. The officials in charge of the work are: Mr. Thomas C. Thompson, Director of the Department of Public Works; Mr. Geo. S. Webster, Chief Engineer, Bureau of Surveys; Mr. J. M. Wilson, Consulting Engineer, P. & R. R. R. Co.; Mr. G. E. Datesman, Principal Assistant Engineer, Bureau of Surveys; Mr. S. T. Wagner, First Assistant Engineer, in charge of the work; Mr. R. I. D. Ashlidge, Second Assistant Engineer, in charge of construction; and Mr. Chas. H. Swan, Chief Draughtsman.

Should a Railroad Adopt Electric Motive Power to Meet the Competition of Electric Suburban Lines?

To what extent a railroad shall strive to retain the traffic which electric lines, actually constructed or contemplated, will otherwise take from them, is a question which a number of railroad companies have already had to consider. It is ably discussed in the twenty-seventh annual report of the Massachusetts Railroad Commission (issued under date of January, 1896), in a chapter devoted to electric motive power. In the same chapter the status of electricity on steam roads is also discussed, and while the conclusions of the Commission may not differ from those of other thoughtful students of the problem, they are so well expressed that we quote from them. The Commission says:

"Whether, taking everything into account, it is as practically convenient and economical to generate at a central station the power of 20 steam locomotives, and by the electrical distribution of this power over the lines of a railroad to move that number of trains, as it is to distribute over the lines 20 steam locomotives, each generating its own power, to haul the trains, is the gist of the question which is at issue between steam and electricity as the better motive power for general railroad operation.

"This question does not as yet admit of a categorical and unqualified answer. In the present stage of electrical development, and in the light of such experience as has been had in the actual use of electric power in railway and railroad operation, the most definite answer that can be given, or that has been given by experts and practical railroad men, amounts to this: The more closely a given railroad service resembles in character that of the ordinary street railway, the better the adaptation to that service of electric motive power; and, conversely, the less the resemblance, the poorer the adaptation. In other words, the most efficient and economical use of electric power will be found where there is a considerable and steady volume of local and short-distance travel, which requires or justifies the running of numerous light passenger trains, at short and regular intervals, so that the trains will be constantly and uniformly distributed over the railroad line. The most efficient and economical use of steam power, on the other hand, will be realized were the traffic is concentrated in heavy trains, run at infrequent and irregular intervals, in accordance with the usual method of conducting through or long-distance transportation.

"In passenger traffic, the public demand and the railroad policy have been in the direction of more frequent and quicker trains. In freight service, on the contrary, where there is no such pressure or occasion for frequent trains at high speed, the policy has been in the direction of fewer and heavier trains. The whole tendency of modern railroad development has been to cut down grades and to increase the weight of engines and of tracks, so as to enable a single locomotive to haul a heavier freight train load. It has been estimated by good authority that doubling the number of engines for a given traffic increases the cost of transportation about 50 per cent. The general tendency of passenger traffic may therefore be said to lie in the direction in which electricity is the most serviceable, while the reverse is true as regards freight traffic.

"With respect to speed, extraordinary claims are made by those interested in the development of electric traction, but there is no question that the steam locomotive is fully capable of developing as high a speed as it is desirable or prudent to use. A railroad speed of 100 miles or more an hour is, for the present purpose, a matter of merely curious speculation. It cannot be shown that there is enough traffic demanding this speed to pay the excessive expense of operation, even if with present methods of construction and equipment it were otherwise at all practicable. Before any such speed is seriously thought of, there must be radical improvements in safety appli

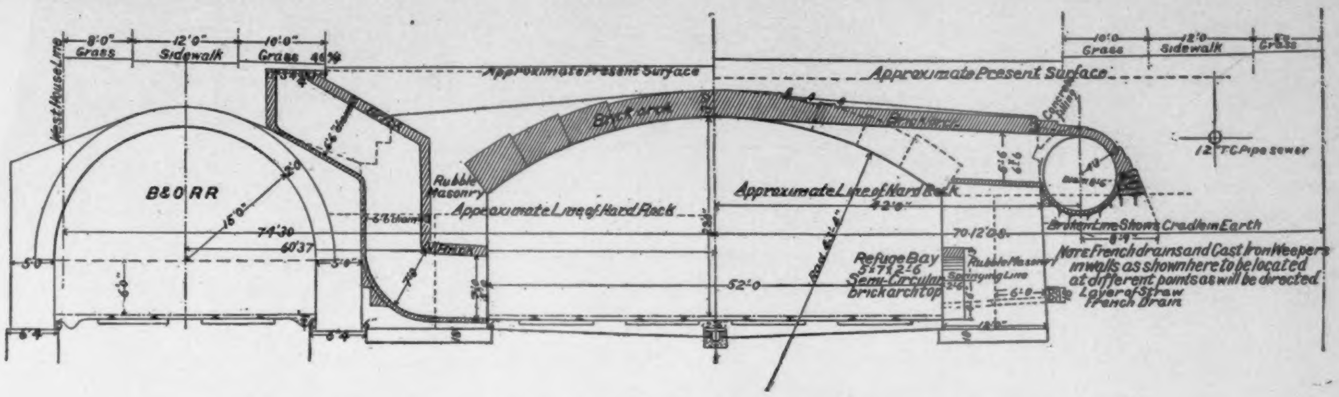


Fig. 3. Section Through Philadelphia & Reading and Baltimore & Ohio Tunnels.

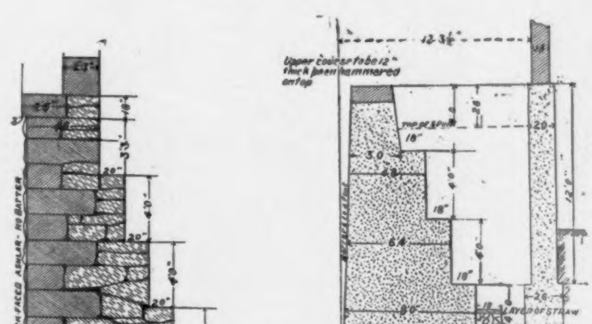


Fig. 4. Sections of Abutment and Retaining Wall.

ances, as, for example, in brakes and in signals. Whatever the proposed rate of speed, the question of signals becomes at once of importance, since, with the adoption of electricity, all systems of electric signaling which depend on the use of the rail circuit must be modified or abandoned.

"It is admitted that electricity is not suited to the moving of freight traffic, and it is not claimed that it is economically adapted to the moving of long-distance passenger traffic. Its province in railroad operation must therefore be, if anywhere, in moving suburban passenger traffic, or short distance inter-urban and local passenger traffic, or the isolated traffic of branch and spur lines. The question is, therefore, for the present narrowed down to the expediency of its use for these, or for some of these, last-mentioned purposes.

"Whatever the proposed purpose, the question is one of economy. In other words, will it, on the whole, *pay* to substitute electric for steam power?

"The first cost is, of course, an essential point. This would depend on the amount of traffic to be served and the comprehensiveness of the plan. The work must include not only the erection and equipment of power stations, the electrical equipment of the line, and the provision of suitable rolling stock electrically equipped, but the preparation of the roadway and its appurtenances for the new system of operation. For a road with local traffic only, there should be at least two tracks. It is evident that through trains and the numerous electric trains could not be run on the same tracks; so that, if both kinds of traffic are to be conducted on the line, there must be not less than four tracks. The facilities and accommodations at terminal stations, if not the stations themselves, to say nothing of way stations, must be enlarged and adapted to the additional service. An electric train or car running at a speed of 30 or 40 miles an hour would be as fatal to a traveler on the highway as an express train; and the frequency of such trains, in addition to the through trains, would require the elimination of all grade crossings with public and private ways, as well as with other railroads. The necessity of reorganizing or replacing the electric signal systems has been already referred to.

"The above are some of the principal items of first cost. The outlay would evidently be large, especially on main and trunk lines. The cost of double tracking and electrically equipping the Nantasket Beach Railroad, seven miles long, for summer traffic, appears to have been about $300,000. The first cost must, of course, be capitalized or funded. In order to justify the investment, it should be shown that the earnings will be increased, or the expenses diminished, by an amount sufficient to pay the dividend and fixed charge on the stock issued and debt incurred, and to leave a margin for contingencies and for years of poor traffic.

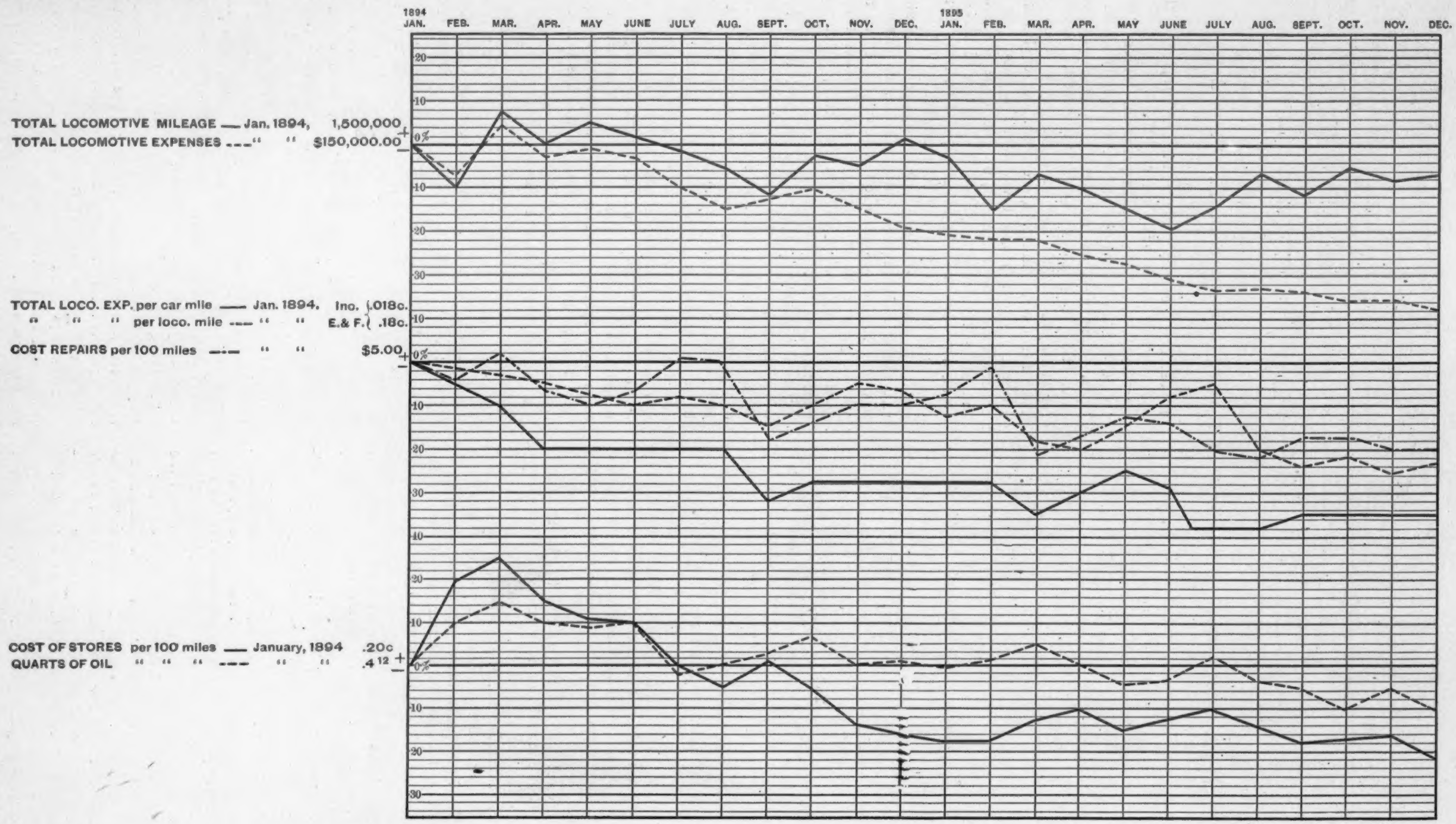
"Nothing can be added to what has been said about the probable expense of maintenance and operation, as compared with steam power. If there is no ground to warrant the assertion that it will be greater, there is as yet no evidence that it will be less. This is an unknown factor in the case, which time and experience must resolve.

"As the whole case now stands, and until further electrical development, we venture the following as the safer conclusion: On a branch or spur line, where the operation may be independent of the main line, and where the present traffic, while not large enough to make steam power profitable, is not too small to be developed into a paying business by a service conducted substantially on the street railway plan of operation, it may be advisable to substitute electric for steam power. There is not, on the other hand, as yet sufficient ground to justify the vote of a prudent stockholder in favor of such substitution on the main lines of a corporation which has a considerable through as well as local traffic, and whose present business is established, remunerative, and reasonably secure."

The Commission then makes a comparison between the electric street railway and the steam road for short distance traffic and finds that the choice of the traveling public is influenced by, 1st, comfort of travel; 2d, speed of conveyance; 3d, frequency of service; 4th, rate of fare; 5th, convenience as regards traveler's point of departure and destination. Of these, the first two are in favor of the steam road, and the last three are on the side of the electric street and suburban system. But it shows that while the third point mentioned above might be met if the steam road adopted electricity, the fourth and fifth could not. The expensive right of way of the steam road and the free use of the city streets by the electric line makes too great a difference in the fixed charges to enable the steam road to make money at the rates of fare charged by the competing electric lines. On the other hand, the controlling advantages as regards long distance travel and freight traffic are decidedly with the steam road. Continuing, the Commission says:

"Nothing will be gained, either by the railroad or the electric railway, by an attempt to control the class of traffic which the other is the better adapted to serve. Neither is the attempt to be encouraged in the public interest. Experience has abundantly proved that there is no advantage to be derived from the establishment of two similar agencies to perform the same specific public service. Competition of this sort leads to combination and ends in consolidation. It is like the unwisdom of laying two gas mains in the same street, for one of which the public has no need, but for both of which the public in the end must pay.

LOCOMOTIVES: Cost of Operation.



A GRAPHICAL METHOD OF RECORDING LOCOMOTIVE EXPENSES.

"If the diversion of short-distance traffic were likely to cripple the resources of the railroads, the question would have for them a more serious import. We anticipate no such result. The disturbing element is not of recent origin. It began with the horse railway; and it is now some seven years since the electric railway has been fastening upon this traffic its farther reaching and more tenacious grasp. Meanwhile, up to the inception of the recent business panic, the traffic and revenues of our railroads kept on rapidly growing year by year. But for the exceptional stringency of the times, there is no reason to doubt that they would have continued steadily to increase. With only a partial recovery from general commercial depression, the net earnings of our railroad companies were larger the last year than in any previous year in their history.* With years of returning prosperity we venture to predict that their traffic and revenues will grow in the future as they have grown in the past.

"Whatever the diversion of short-distance travel, the increase of population and industry which the electric railway will foster and develop along the railroad lines, will still be tributary to the latter in a hundred ways.

"It is, perhaps, unnecessary to add, that there is no apparent demand by the public for the substitution of electricity for steam in general railroad operation. No complaint has come to our ears that the present railroad service, so far as the motive power is concerned, is inadequate or unsatisfactory. The question, as it now stands, is one purely of economy, to be decided by the railroads primarily in their own interest, bearing in mind, as they will, that it is always for their interest to give to the public the best service reasonably in their power. Our railroad managers, we have reason to know, are giving to the subject their diligent attention and study; and they will be alert to introduce the new motive power upon their lines so soon as it shall become manifest that by so doing they can give to the public a substantially cheaper and better service."

The Use of Graphical Methods in Keeping the Accounts of Railway Mechanical Departments.

The value of the graphical method of recording and comparing statistics of various kinds is so generally recognized that its use is daily extending. It has frequently been used in railroad circles, but until recently we have not found it employed systematically and regularly in recording the various monthly expenses of a mechanical department. Such a use of graphics on a large railroad system entering Chicago recently attracted our attention, and through the kindness of the superintendent of motive power, we have been furnished with interesting particulars. We have been asked not to name the road from which our information is obtained, but a few of our readers in official positions have already investigated the workings of the system, and have been charmed with it, and we can probably put others on the track of any additional information they may require.

In establishing the graphical records on the road alluded to, the expenses for the month of January, 1893, were taken as a basis, and the percentage of increase or decrease in each item was calculated and shown graphically. Three separate sheets were decide upon, one for shops, one for cars and the third for locomotives. Not more that three items are grouped under one set of lines, though there may be several such groups on the one sheet or chart. On the sheet for the shops is shown the total locomotive mileage, the total car mileage, the total material received, the total material charged out, the material on hand, the total shop labor, excluding engineers' and firemen's wages. Under the heading of cars is shown the passenger car mileage, the cost of passenger car repairs per mile, the cost of passenger car lubrication per 1,000 miles, the cost passenger car cleaning per car; the total freight car mileage, freight car mileage loaded, freight car mileage empty, cost of freight car repairs per mile, and cost of freight car lubrication per 1,000 miles. Under the sheet for locomotives is given the total locomotive mileage, total motive power expenses including engineers' and firemen's wages, the total motive power expenses excluding engineers' and firemen's wages, the total locomotive expenses, total locomotive expense per car mile, total locomotive expense per locomotive mile, cost of repairs per 100 miles including new locomotives, cost of locomotive repairs per 100 miles excluding new locomotives, cost of fuel per 100 miles, pounds of coal per passenger car mile, pounds of coal per freight car mile, cost of lubrication per 100 miles, quarts of oil per 100 miles, passenger and freight, and cost of stores per 100 miles.

The records are kept on tracing cloth 22½ by 44 inches, ruled like profile paper. These tracings are filed in the drawing room and kept up to date by the draftsman through information furnished him each month.

In the illustration on page 100 we reproduce a part of the locomotive sheet showing seven of the items mentioned. It is a facsimile as far as the general arrangement is concerned, but the values given are fictitious, although approximate, and they refer to January, 1894, as a basis. The diagram is ruled with vertical lines representing the months, and at each group of items there is a heavy horizontal base line with parallel rulings above and below it, for each two per cent., those above representing increase and those below, decrease. The percentage of increase or decrease for each item is laid off on each monthly line, and the points connected with a line of a character designated on the left-hand margin. Thus the locomotive mileage which in January, 1894, was 1,500,000, was 10 per cent. less in February, and 8 per cent. more in March of the same year. In December, 1895, it was 7 per cent. less, while in the meantime the locomotive expenses decreased nearly 38 per cent.

In the same way we are shown in a striking manner the falling off in the cost of repairs, in the cost of stores, and in the locomotive expenses per car and per locomotive mile. It needs no argument to convince any reader that the expenses of the department are shown up in a more comprehensive manner by this graphical method than can possibly be done by the use of tables of figures, however carefully they are prepared. This graphical system is worthy of extensive use in mechanical departments, and where adopted it might lead to economies, the need for which is not at present realized. In our example the falling off in expenses is of course to be largely attributed to the temporary retrenchment which that road in common with others has had to practice in the last two years.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.—Second Series.—Chemical Methods.

XVIII.—Method of Determining the Fineness of Grinding of Freight Car and Passenger Car Color.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

In the purchase of paints there is always a question in the mind of the consumer as to the fineness of the grinding. And since it is well known that not only the satisfactory working of the paint under the brush, and the appearance of the surface when the painting is finished, but also the durability of the work is affected by the fineness to which the paint has been ground, it is obvious that the grinding of paint is an important matter. Moreover, as paints are ordinarily ground, from 10 to 20 per cent. of the price of the paint is for the grinding, and as it would be easy by insisting on much finer grinding to increase the cost 20 to 30 per cent., it is clear that the financial side of paint grinding is not its least important phase. Several methods of determining the fineness of grinding have been proposed. One of these is to put a little of the paint on one thumb nail and rub it with the other. If there is no scratching or gritty feeling the paint is supposed to be finely enough ground. Experience shows, however, that both the nature of the pigment, and the nature of the menstruum used along with the pigment, as well as the individual characteristics of the operator, all affect this test, so that its indications cannot be regarded as sufficiently reliable to be of much value. Another test is to mix with the paint quantities of some liquid which dissolves the menstruum completely, and does not dissolve the pigment, and then see if the whole mass, pigment and liquid together, will run through a sieve which has been decided on as the

* This, of course, refers to the railroads in the State of Massachusetts.—EDITOR.

standard of fineness. For example, if 100-mesh or 150-mesh sieve has been decided on as the standard of fineness, it is obvious that if part of the pigment is left on the sieve, the paint was not finely enough ground. Still another test of similar nature is to separate some of the pigment from the menstruum and examine the dried pigment under the microscope, measuring the size of the particles if desired. It is obvious that both these tests simply tell something in regard to the fineness of the pigment. They do not give any information as to how well the pigment is mixed with the menstruum, which is one of the important elements in the grinding of paint. Indeed, experience shows that with either of these tests it would be quite possible to pass paint as well ground which had never been in a mill at all, it having been simply mixed in a "chaser." Moreover, it is very difficult to get a sieve which even approximates in mesh the fineness desired in well-ground paints. Also in the miscroscope test there is very great difficulty in being sure that aggregations of particles are not being measured instead of the particles themselves. In view of these difficulties, it is clear that there is need for some test which shall be definite and positive, which shall give results always alike, which shall be unaffected by the individuality of the operator, and which shall tell what it is essential to know, viz: (1) That the particles of the pigment are themselves sufficiently fine, and (2) that they are properly mixed with the menstruum. It is believed that the test which is described below accomplishes these results in a satisfactory manner. The test is described as applying to paints purchased in the paste form only. It is thought, however, that the principles involved in the test being made clear, modifications of the method can readily be made which will make it applicable to all kinds of paints, with the possible exception of those in which the proportions of pigment to liquid are outside the limits of the test.

OPERATION.

Weigh into a small porcelain dish in the case of freight-car color two (2) grammes of the paste, and add one (1) gramme of pure raw linseed oil, and in the case of passenger-car color five (5) grammes of the paste, and add three (3) grammes of pure raw linseed oil. Stir with a glass rod having a rounded end, until the material is a homogeneous mass. Have ready the cooling chamber and the strips of glass described below, which have been brought to a temperature of 70 degrees Fahrenheit by passing warm or cool water through the cooling chamber. Place the dish containing the material to be tested in the cooling chamber, and allow it to stand half an hour. Then stir thoroughly again and with the glass rod place a few drops of the material on one end of one or more of the strips of glass, place the glass vertically in the cooling chamber, with the end containing the spot of paint uppermost. Replace the cover and allow it to stand for half an hour. The material runs down the glass in a narrow stream. At the end of the time remove the cover, and examine the strips of glass, best by holding them between the eye and the light. If the liquid has not separated from the pigment for an inch down from the top of the test, that is, if the stream of paint is smooth, continuous and completely opaque for this distance, the paste is sufficiently fine ground. On the other hand, if the liquid has separated from the pigment, leaving little patches and ridges of pigment, and apparent rivulets down which the liquid has passed, leaving more or less pigment behind, the stream of paint being more or less rough and irregular on its surface, and more or less transparent, the paint is not sufficiently well ground.

APPARATUS AND REAGENTS.

Any convenient porcelain dish will do for the mixing of the paste and oil. One 2½ inches in diameter across the top and 1 inch deep does nicely.

The cooling chamber may perhaps best be described as one metallic box inside another one, the spaces between the two being filled with water of the proper temperature, and the inside box being fitted with a cover. In order to make the construction clear, let us describe as follows: Make a completely closed box of sheet copper 10 inches square and 8 inches high. In the top cut a hole 6 inches square. Into this hole slip another sheet-copper box, 6 inches square and 6 inches deep, but without a top. Make all joints tight. Fit the 6-inch box with a removable cover. Make two holes, half an inch in diameter, in the top of the larger box to serve as inlet and outlet for the cooling water, and into one of which a thermometer may be placed to take the temperature of the water. It will be seen that we thus have the inside box as a cooling chamber, surrounded on five sides by a layer of water approximately 2 inches thick. The cover being placed on the smaller box, it is evident that the space inside the smaller box, or any articles placed in it, will, after a proper time, become very closely the temperature of the layer of water. If now this is adjusted to 68 or 69 degrees Fahrenheit, the temperature of the chamber will be very near to 70 degrees Fahrenheit, the desired temperature, if, as is customary, the apparatus is used in a room or laboratory which is kept from 70 to 80 degrees Fahrenheit.

The strips of glass used are about an inch wide and 4 inches long. They should be dry and before use should be brought to the same temperature as the cooling chamber, by standing them vertically around the sides of the chamber for at least half an hour.

The linseed oil to be mixed with the paste should be pure raw oil, and should not be allowed to get old.

CALCULATIONS.

The results of this method being simple observations, no calculations are required.

NOTES AND PRECAUTIONS.

It is evident that this method depends for its success on the fact that a moderately viscous liquid like linseed oil does not separate from particles of solid matter, under certain conditions. The principal conditions which have been found to affect the test are as follows: 1st, the temperature; 2d, the proportions of pigment and liquid; 3d, the nature of the liquid; 4th, the nature of the pigment; 5th, the completeness with which pigment and liquid are mixed, and 6th, the fineness of the pigment. It is not claimed that no other conditions affect the test, but these are believed to be the principal ones.

It is obvious that by increasing or diminishing the temperature at which the test is made, the viscosity of the liquid is increased or diminished, with consequent increase or decrease in its ability to leave the pigment. The higher the temperature, the more limpid the liquid, and the less its likelihood of staying with the pigment.

The proportions of pigment and liquid have a very important influence on the test. Indeed it is this variable which is generally used in applying the test to various kinds of paints. The proportions given under "Operation," as applying to freight-car color, are different, it will be observed, from those applying to passenger-car color. These proportions are determined by experiment, and may be different for every kind of paint, depending on the nature of the pigment, the nature of the menstruum in which the pigment is ground, the temperature at which the test was made, how completely the pigment and liquid are mixed, and especially the fineness desired. The standard freight-car color of the Pennsylvania Railroad Company is a mixture of about 75 per cent. pigment, with 25 per cent. of pure raw linseed oil, both by weight. The pigment is a mixture of about 25 per cent. of sesquioxide of iron, with 75 per cent. of inert material, partly clay, partly sulphate of calcium, partly silica and partly carbonate of lime. With this pigment and this liquid, it will be observed that the proportions in the mixture which is subjected to test for fine grinding are one-half pigment and one-half liquid by weight. (Two grammes of paste are taken, of which 1½ grammes are pigment, and one-half gramme oil. One gramme of oil is added, making 1½ grammes of pigment, and 1½ grammes of liquid.) The standard passenger-car color of the Pennsylvania Railroad Company is a mixture of about 75 per cent. pigment, and 25 per cent. liquid by weight. The liquid is a mixture of about 36 per cent. pure raw linseed oil, and 64 per cent. of spirits of turpentine, also by weight. The pigment contains approximately 80 per cent. sesquioxide of iron, 5 per cent. carbonate of lime, from 5 to 10 per cent. of wood or other lake, and a little inert material. With this

pigment and this liquid, it will be observed that the proportions in the mixture which is submitted to test for fine grinding are about 47 per cent. pigment and 53 per cent. liquid by weight. (Five grammes of paste are taken, of which 3¾ grammes are pigment, and 1¼ grammes are liquid. Three grammes of oil are added, making 3¾ grammes of pigment, and 4¼ grammes of liquid.) It would be easy, by varying the proportions of pigment and liquid either way from the figures given, to increase or diminish the severity of the test. A recent attempt to increase the fineness of the grinding of the standard freight-car color, so that the proportions used would be two grammes of paste and two grammes of oil, or about 40 per cent. pigment to 60 per cent. liquid, brought from the manufacturers the statement that to do this would compel them to charge at least 25 per cent. more per pound for the material.

The influence of the nature of the liquid on the test is not difficult to understand. If a paint is ground in japan or varnish, it is clear that the results would be quite different, the test being otherwise the same, than if raw oil or oil and turpentine were used. The more viscous the liquid, or the more the adhesion between pigment and liquid, due to its stickiness, the coarser the grinding may be, and still the material stand the test as above described. Of course by modifying the conditions, such as increasing the proportions of liquid or adding to the paste, turpentine or some other limpid liquid, instead of oil, entirely satisfactory results may be obtained, whatever the nature of the liquid used in grinding the paint. Moreover, direct experiment shows that by adding a single drop of water to material which does not quite stand test, and stirring with the glass rod until the water is uniformly mixed, the material will stand test. The addition of the water apparently converts the oil into an emulsion, which remains with the pigment better than the oil alone. Furthermore, if the oil added to the paste is old, and has become in consequence what the painters call "fatty," shipments will not stand test which are satisfactory when fresh raw oil is used. Apparently the old or fatty oil being changed or different in its nature from fresh oil does not adhere to the pigment as well as the fresher oil. Whatever the explanation, the fact remains.

It seems evident that the nature of the pigment, especially its specific gravity, its mechanical condition, whether compact or flocculent, and especially whether the liquid used wets or adheres to it, or is repelled by it, have an important influence on the test. The exact influence of each of these variables has not yet been worked out.

The influence of the mixing of pigment and liquid on the test may be made quite evident by separating and drying some pigment from a sample of paste which stands test all right, and then mixing some of this pigment with the proper amount of oil, and stirring with a glass rod, and finally submitting some of the material to the test again. It will be found that no amount of stirring, notwithstanding the pigment is so fine that it has once stood test, will ever bring the material into the same condition that it was left by the mill before it was first submitted to test. It seems almost impossible to break up all the aggregations of particles of pigment, and mix them uniformly with oil or liquid by any other means than the mill or its equivalent.

Perhaps the best illustration of the effect of the fineness of the pigment on the test may be obtained by testing any sample of paste for fine grinding, and then passing it through a mill again, testing it again, and so on, taking care to tighten the mill each time before regrinding the paint. It will be found that each grinding, if it is properly managed, makes the material stand a severer test, as shown by the fact that continually more and more oil may be mixed with the paste and still the sample stand test.

It is obvious that this test gives no absolute standard of fine grinding, and that different paints made from different pigments and liquids cannot necessarily be compared with each other by means of it. The query may arise as to when a paint can be said to be ground finely enough. The answer is that this is a question of the uses to which the paint is to be applied, and of money. For freight-car work, or for the outside of buildings, it would probably be poor policy to grind paints as finely as for passenger-car work, or for the insides of rooms or carriage work or artists' work. On the other hand, there is no doubt but that, for most paints at least, the finer they are ground the more surface they will cover, the more durable they will be, and the more economically and successfully they will be used in the shop, giving at the same time a better job. But, as already stated, the grinding of paint is an expensive process, and, therefore, in each case, how fine the paint shall be ground, must be decided by the conditions.

It may be thought that the stirring with a glass rod to mix the added oil with the paste will have an influence on the test. Experience indicates, however, that the influence of stirring, if any, is so slight that its effect can be ignored.

The direction not to use old or fatty oil has already been commented upon, and the influence of this explained. The effect of water mixed with the paste has also been mentioned. It should also be stated that if a little alkali, caustic or carbonate of soda, or potash, or wood ashes, or caustic lime is added to the paint during grinding, it will stand test with a good deal coarser grinding than if none of these substances are present. In all critical cases it is essential to prove the absence of these materials before being satisfied that the paint is ground sufficiently fine.

Tests may be desired of paints which contain such large proportions of liquid, and such small proportions of pigment, or in which the liquid is so limpid, that however finely the paint may have been ground, the liquid will separate from the pigment when tested. It is obvious that this method does not apply to such paints as these. It is also evident from what has preceded that the same standard of fine grinding does not apply to all paints, but rather that each kind of paint has its own standard, which standard is determined by experience and the conditions of its use.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—VI.

BY OSCAR ANTZ.

(*Continued from Page 75.*)

DRAFT GEAR—CONTINUED.

There seems to be a tendency with many car builders at the present time to use metal instead of wood in the construction of certain parts of cars, where it can be done to advantage, where, for instance, the parts can be made stronger, lighter, cheaper or less difficult to apply in metal, or where the wood is more than usually subject to decay. No general attempt has yet been made to substitute metal for wood for draft timbers, although in some individual cases of special cars built almost entirely of metal the draft timbers are also of the same material.

A step in this direction has, however, been recently made in the introduction of a device in which "draft arms," made of malleable iron, are substituted for the draft timbers, the drawbar stops and other attachments being made part of the same casting. Figs. 31 and 32 show this arrangement as applied to a car; *A A* are the malleable iron draft arms, which are made in pairs, and each is fastened directly to the sills and face block by four 1-inch bolts, having heads resting in socket castings let into the floor. These draft arms have flanges cast in them at *B B*, against which the followers *C C* rest, forming a front drawbar stop. At the rear end of the draft arms are fastened the back drawbar stops, *D D*, which are held each by one of the bolts through the center sills, and transversely by two bolts passing through both back stops and both draft arms, the back stop acting as distance pieces. Into these back stops are fitted wooden subsills, *E E*, bolted to bottom of center sills and extending, if possible, back to the cross-tie timbers; similar blocks may be fitted between the latter timbers, forming practically a continuous draft timber from end to end of car, to take butting strains. To take pulling strains, flanges are provided on the outside of the draft arms for the reception of the nuts of the draft rods, *F F*, which extend to and through the crosstie timbers, with nuts on the back of these. Similar rods tie together the cross-tie timbers.

Drawbar guides, *G G*, are provided on the bottom of the draft

arms, the upper guide being formed by the casting itself. The front end of the draft arms is provided with a shoulder, which rests against the projecting portion of the face block, *H H*. Lugs, *I I*, cast on the inside faces of the arms, form guides for the front end of the drawbar. A carry iron, *JJ*, of the usual shape is provided under the face block, and just back of it, under the end sill, is

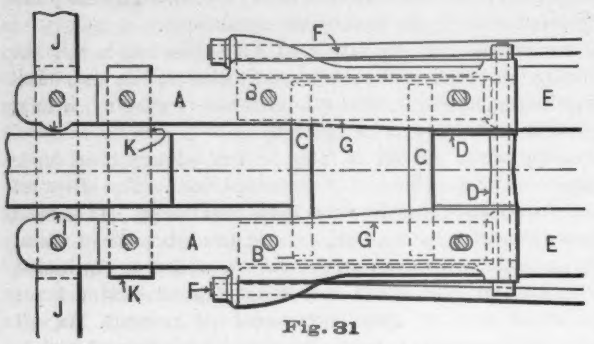


Fig. 31

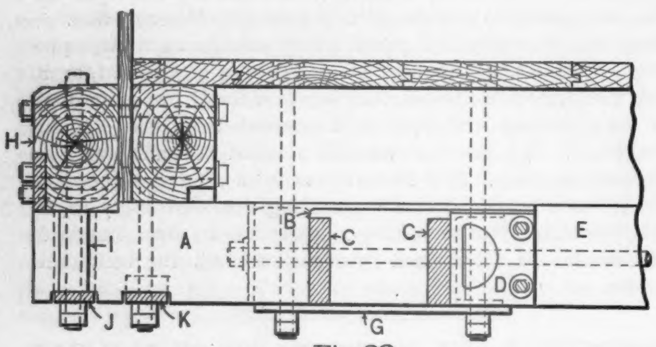


Fig. 32

located an additional tie strap, *K K*, both carry iron and tie strap being let into recesses in the bottom of the arm.

The draft arms shown in the drawings is proportioned for follower plates to take two springs side by side, but of course they can be made for the standard length of follower plate just as well.

DRAWBARS.

The one part of the draft rigging of cars, which has undoubtedly received the most attention, is the coupler or drawbar. The freight couplers in this country, while varying greatly in detail, yet combine in nearly all of them, the general principles of simplicity, ease and rapidity of operation, and in this respect differ so much from many styles in use in other countries, that a passing remark about these will not be out of place. The general idea of most of these foreign couplers is that of a link on one car, passed over a hook on the other and combined often with a more or less elaborately arranged system of screws, levers and springs, by means of which the cars are drawn closely together when coupled; the time and care necessary to couple cars with these contrivances seem entirely out of place to American ideas.

In the early days of railroading this hook and link found its way into American equipment and is still found as the so-called "three link" coupling on some of the four-wheeled coal cars in use on a few of the roads in the Middle States, but is being retired with this class of cars.

The distinctive American coupler of the earlier days is the link-and-pin coupler, in which the drawbars are made with pockets for the reception of a link connecting the two bars, which is secured in each bar by a pin passing through each end of the link and through holes in the bar; this coupler is now considered obsolete and no sketch of it is, therefore, given. Link-and-pin drawbars have been made of cast, wrought and malleable iron, each metal requiring some shape peculiar to itself. Connection to the draft gear was made at first by means of the spindle or tail pin, but was eventually superseded on many roads by the spring pocket or yoke, or some continuous attachment. In coupling cars with the link and pin, the link must be secured in one drawhead and held up and entered into the other drawhead when skill and is attendant with considerable danger to the switchman, who has to step between the cars to make a coupling. To avoid this danger, a great many devices have been gotten up in connection with this style of drawbar, from a simple rod or stick in the hands of the trainmen, to more elaborate ones combining a mechanism to hold up the link with another to drop the pin, but none of these devices have stood the test of severe service on the road, although some of them seemed to possess at least some good points.

Other inventions were introduced doing away entirely with the link and pin and substituting lugs or similar contrivances projecting from the drawbar which interlocked with each other, and eventually the design, which is now considered a standard in this country was devised. It is the policy of the M. C. B. Association not to recommend any article of a particular manufacture, and no particular coupler is therefore prescribed as a standard, The outlines, however, of the parts in contact when coupled, as well as the sizes and distances of certain other parts are given. which should be followed within certain limits, irrespective of details of the coupling mechanism.

In Figs. 33 and 34 are shown the parts of the coupler which have been adopted as standard. *X X* is the contour line, which is composed of straight lines and arcs of circles, and only the parts in heavy lines are prescribed, the parts of the head back of this being left to the discretion of the designer, as they are not essential to the proper working of the coupler. Variations of $\frac{1}{16}$ and $\frac{3}{32}$ inch at different points are allowed on each side of this contour line, and gages have been devised, giving the limits which must not be exceeded, by means of which couplers and knuckles can be rapidly and accurately tested. The drawbar is 30 inches long from centre line of contact to the end. It is five inches square just back of the head, at *A A*, and has a horn, *B B*, projecting above the head, $8\frac{3}{4}$ inches from centre line of contact; at the rear end are provided rectangular lugs, *C C*, $5\frac{1}{2}$ inches long, 4 inches wide and $6\frac{1}{2}$ inches over the horizontal surfaces, to take a pocket strap. Two $1\frac{3}{16}$-inch holes are provided, located as shown, for bolting or riveting the strap to the bar by means of $1\frac{1}{8}$-inch

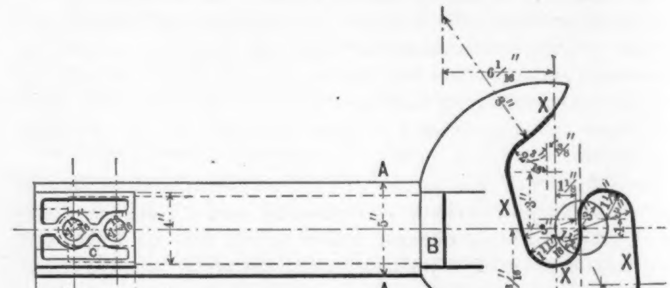


Fig. 33

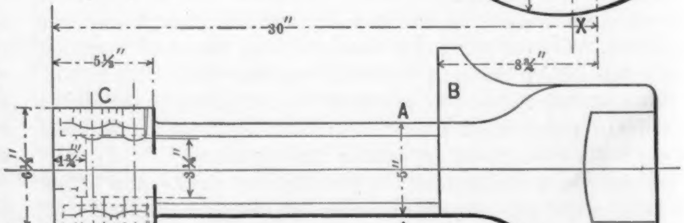


Fig. 34

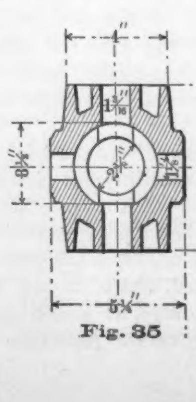


Fig. 35

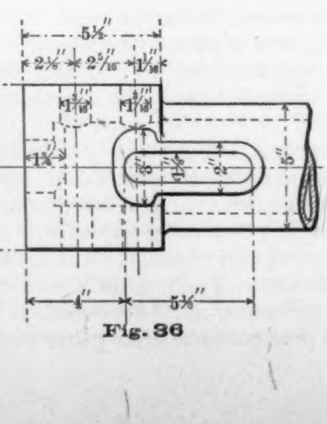


Fig. 36

the cars come together, and the pin must be dropped at the same time, before the impact separates the cars again. This performance requires more or less bolts or rivets. A hole 2¼ inches in diameter and 1⅝ inches long is provided for a 2-inch tail pin, the drawbar being cored out with a 3½-inch hole, both the hole and the head of the pin resting in it being flattened on the bottom to keep the pin from turning. When the drawbar is used in connection with the continuous arrangement illustrated in the last article, the rear end shown in Figs. 35 and 36 is used, a horizontal slot for a 1 by 5-inch key being cast in it.

The number of different makes of couplers which conform to the M. B. C. standards is increasing constantly, and it would be out of the question to say that this or that one is the best; naturally the first ones in the market have been adopted by a number of roads, and are being applied to a great extent, but as competition has lowered the price, the newer ones are coming in for some share of the patronage. Elaborate tests have been made and specifications drawn up from time to time, to which drawbars should conform, but as yet no standards for strength or for the dimensions of other points, excepting those mentioned, have been adopted. The question as to the best material for drawbars is still an open one, but malleable iron and steel are at present considered as really the only metals which should be used, and

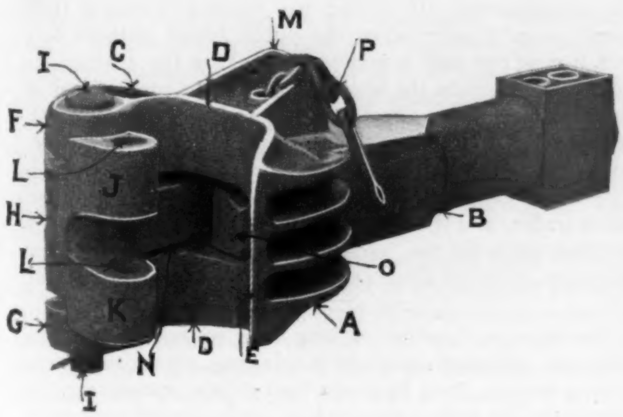


Fig. 37.

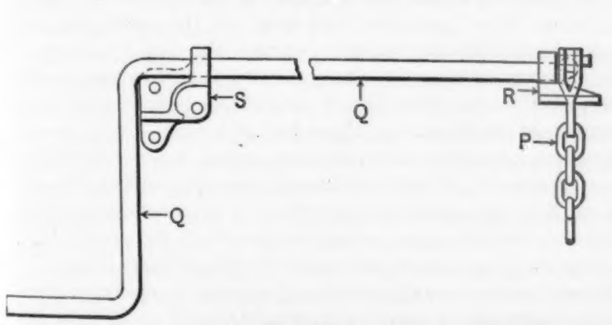


Fig. 38.

each has its numerous friends; the tendency seems to be that drawbars will hereafter be made usually of malleable iron, and the knuckles will be steel castings, which is the practice of many makers at present. The other parts of the coupler are of minor importance and the material in them is generally governed by local conditions in design or manufacture.

Although all the various drawbars differ in the details, they agree in general principles in the more essential parts, and these are shown in Figs. 37 and 38. The drawbar consists of the head, *A A*, and the shank *B B*. *C C* is the side wall ofthe head, *D D* the front face, *E E* the guard arm, *M M* the horn. Upper and lower lugs, *F F* and *G G* are provided, between which the knuckle, *H H* swings around the knuckle pin, *I I*. The knuckle has upper and lower lugs, *J J* and *K K*, leaving a slot which is used, when necessary to receive a link which is held by a coupling pin in the pin hole, *L L*. The knuckle terminates in the tongue, *N N*, which engages with the lock, *O O*; the latter is raised and lowered by a chain, *P P*, attached to the uncoupling shaft, *Q Q*, fastened to the end sill or end of car by brackets, *R R* and *S S*.

The principal difference in the various makes of couplers exists in the knuckle and locking arrangement. Many do not confine themselves to the simple lock, but introduce cams and springs. Knuckles are often arranged to open automatically when the lock is moved, some by means of a spring and some by means of gravity, inclined planes being introduced on the bottom of the knuckle and its bearing point on the head. The lock is usually held in place by gravity alone, and the use of springs for this purpose should be condemned.

Some couplers have been introduced which meet all the requirements of the law, in that they "couple automaticly by impact" with each other, but which are not at all like the standard of the M. C. B. Association, and will not couple with this class of coupler without the use of a link and pin. These couplers are no improvement in their most essential part over the old style of drawhead and are mentioned here only as being a good thing to avoid.

In order to be able to couple and uncouple cars without stepping between them the uncoupling rod is extended to the side of the car as shown in Fig. 38. This rod is usually made of 1-inch round iron with an arm bent on it at the centre of the car extending over the coupler to which is attached the chain leading to the lock; the outer end is bent in the form of a crank handle, which when not in use hangs down on the face of end sill or end of car. To release the lock the handle is raised, and if dropped again, the lock will return to its former position; if the knuckle is open and is suddenly thrown back it will raise the lock, which then drops in front of the tongue and holds it in the closed position, until again released. The uncoupling shaft is now usually placed on the left side of the end of the car, the observer standing on the ground facing the end under consideration.

In the switching of cars it is sometimes desirable that the coupler of two adjacent cars be so arranged that they will not couple in case the cars should be moved closely together. This is attained by holding the uncoupling shaft in a position in which it will keep the lock out of action, the usual methods being to provide lugs or slots on one of the brackets in which the shaft works, which will keep the shaft in the desired position if lifted slightly or moved a short distance in the line of its axis.

One of the principal sources of trouble which developed with the introduction of the M. C. B. coupler was that on account of its size it formed quite a serious obstruction if by accident it was pulled out of the car and dropped on the track, and quite a number of wrecks have been caused in this way by the breaking of a tail pin or key. The substitution of the spring pocket for the tail pin on many roads has done away with the primary source of this difficulty, but on cars which still have the spindle other means must be introduced. It has been suggested that the claim of the unlocking device be made of such a length that should the coupler be pulled out an unusual amount it will raise the lock and thereby release the coupler from its adjacent one, preventing its being pulled out completely. An objection is raised to this plan in that the coupler is liable to be released when subjected to a sudden pull, even when there is no defect in the pin.

A device for holding up a coupler after it has been pulled out has been introduced in several modifications, the general principle being the fastening of a Z-shaped casting or forging to each coupler, just over or under the knuckle of the engaging coupler, on which the coupler which is pulled out will hang suspended.

Another means of preventing accidents by trains parting, either by drawbars uncoupling or pulling out, is that of safety chains, and the M. C. B. Association has considered these important enough to recommend a standard practice to be pursued in applying them. Safety chains on freight cars are, however, so little used, that it really seems like adopting the foreign hook-and-link coupling in addition to our own, which in itself should be sufficient, and the subject will not be further touched upon here.

(To be continued.)

(Established 1832.)

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CONTENTS.

OUR NEW FORM.

At the time that the *American Engineer and Railroad Journal* was consolidated with the *National Car and Locomotive Builder*, owing to existing contracts for advertising, it was impossible to adopt the preferable size and form of the first named paper for the new publication. Since then negotiations with advertisers have made it practicable to change the size of page and general make-up of the paper to that which is presented to our readers in this number. It is hoped that it will commend itself to them, and it is the intention of its owner and editors in making the change to improve not only its form, but also the matter which it will contain, and it will be their aim to make its contents more interesting and valuable hereafter than they have ever been during any portion of the past sixty-four years of its existence.

The problem of the application of electricity to steam roads, as it now confronts managers of the latter interests, is neatly stated by the Massachusetts Railroad Commission, and will repay a careful reading. The question is one of economy. The mechanical and electrical questions have already been solved or are capable of solution without going too far into the field of the experimental. If a road can employ electricity in certain localities and thereby serve the public better, without loss to itself, it most certainly is justified in making the change, but if it adopts electricity in the hope of crushing the competition of suburban or inter-urban street-car lines and wresting from them a traffic which is naturally theirs, even if it has heretofore been conducted by the steam road, the move is one of doubtful wisdom. The steam roads need not fear outside competition for long-distance traffic, and if electricity ultimately becomes more economical than steam for the transportation of heavy trains over long distances, it will be adopted without the pressure of competition.

The paper on the effect of long pipe connections on indicator diagrams, published elsewhere in this issue, is worthy of more than passing notice. In it Professor Goss shows conclusively that the effect upon the area of the card is much greater than is usually supposed, and that for all ordinary work it causes the card to show a greater mean effective pressure than actually exists in the cylinder. It is probable that most of the indicator work in marine and stationary engine practice has not contained appreciable errors, because the connections have usually been quite short, but in locomotive practice few cards have been taken where the pipes were less than about three feet in length. Such cards may, therefore, be considered as too inaccurate to serve as the basis of very important deductions, though they may suffice for ordinary work. It would appear that what is now wanted is an indicator rig that can be applied to locomotives in which the pipe connections will be short enough to practically eliminate these errors. This is not easy, for large modern locomotives have so little clearance over the cylinder casings that a rig occupying any great space ou side of the steam chest casings is in danger of being stripped off while the engine is running, and such a location of the indicator adds greatly to the danger to the operator. It is interesting to note that if the areas of cards taken at high speed are ten or more per cent. in excess of the actual mean effective pressure in the cylinders, train resistances, which already appear to be surprisingly low under such conditions, must be scaled down still further, thus making commonly accepted rules appear more inaccurate than ever.

PUMPS VS. COMPRESSORS FOR SHOP USE.

We had thought that everybody was convinced of the fact that air for shop use cannot be economically compressed in air-brake pumps, but if the May meeting of the Central Railroad Club is correctly reported in the Buffalo papers (and these reports are usually official), a committee submitted a report on air-brake testing plants in which they advocated the use of

pumps instead of compressors on the score of economy, and in the discussion that followed, Mr. Higgins, of the Lehigh Valley, and Mr. McKenzie, of the Nickel Plate, were the only dissenting parties. Unfortunately for the committee, if their opinions are correctly quoted, it can easily be proven that it is economy to replace even a single pump with a compressor, and, in testing plants adjacent to shops where air can be used for other purposes also, thus requiring the capacity of several pumps, their use instead of compressors is extremely wasteful.

Comparisons between large steam-air compressors and pumps have been made in the past, but we are not aware that any attempt has been made to show the relative economy of pumps and small steam or belt compressors. For that reason it may be well to enquire into the matter. Two years ago the writer made some tests of 8-inch brake pumps in which it was found that for every pound of steam passing through the pumps there was on the average about 2.25 cubic feet of free air compressed to 70 pounds pressure. For every 1,000 cubic feet of air compressed there is therefore required 445 pounds of water, and if the evaporation of the boiler supplying the steam is taken at 8, the coal required is 55.6 pounds. The capacity of one 8-inch pump with 80 pounds of steam is about 1,000 cubic feet per hour, and if we assumed that the pump ran the equivalent of 10 hours per day for 300 days in a year the annual coal consumption is $55.6 \times 10 \times 300$, or 83 tons. As it is seldom that a single pump is of sufficient capacity for a yard or shop and as even the smallest belt compressors are usually of the capacity of two such pumps, we will first make a comparison on the basis of 2,000 cubic feet of free air compressed per hour, requiring two pumps consuming 166 tons of coal per year. It might here be remarked that as the speed of pumps vary considerably with slight differences of pressure, it may reasonably be urged that one pump might be made to do this work if higher steam-pressure were used; but if this is done the coal consumption is not altered materially, nearly the same amount of steam passing through one pump instead of two.

In considering compressors of small capacity those driven by belts must not be overlooked. We find by investigation that in this type about 2.8 horse power is required at the belt for each 1,000 cubic feet of air compressed per hour. If the shop engine consumes 3½ pounds of coal per horse power per hour and the loss in transmission by shafting, belts, etc., is 40 per cent., the coal per horse power at the compressor becomes $3.5 \div .6 = 5.8$ pounds, and for compressing 2,000 cubic feet of air it is $2.8 \times 2 \times 5.8 = 32.4$ pounds. For a year of the same number of hours as before, the consumption is $32.4 \times 10 \times 300 = 48\frac{1}{2}$ tons.

In a steam compressor the horse-power per 1,000 cubic feet of air compressed, including the internal friction of the engine, we will take as 3.2, though it will vary somewhat with the construction of the compressor. In one having only 2,000 cubic feet capacity per hour a horse power cannot be expected on less than 4½ pounds of coal with the evaporation we have assumed, and it might easily be more. Taking it at that figure the annual consumption would be $3.2 \times 2 \times 4.5 \times 10 \times 300 = 43$ tons.

Now a belt compressor of 2 000 cubic feet capacity per hour and provided with an automatic regulator or governor can be bought for from $200 to $250, and a steam compressor of that capacity will cost in the neighborhood of $350. Two brake pumps, even if they are not new, will represent an investment of from $100 to $200 according to their age. The comparison between the two types of compressors and the pumps might be summarized in tabular form thus:

	Value of invest-ment.	Coal con-sumed in tons per annum.	Cost of fuel per annum at $1 per ton.	Saving per annum.	Saving capital-ized at 6 per cent.
Two second-hand pumps.	$100	166 tons.	$166 50	....	....
One belt compressor	225	48½ "	48.50	$117	$1,958
One steam compressor.....	350	43 "	43	123	2,050

From the columns showing the annual saving and the same capitalized at 6 per cent., it will be seen that if the air-brake pumps were to be had for nothing it would still pay to buy the compressors if they cost less than $2,000. Perhaps a more striking way to view it is that if a road were offered two pumps and a bonus of $1,500 with them, their use to be confined to pumping air for shop use, it would be wise to refuse the offer and to purchase a compressor at market prices. If only one pump were needed it would still pay to buy a compressor of the size mentioned above, and the saving per year in fuel would still be more than $50.

We think the above figures are fair and not in the least exaggerated. If any one is disposed to quibble over some of the items, let him consider what the comparison would become according to his own figures if coal were at the same time taken at, say, $2.00 per ton, a price which many pay for it.

The figures seem to prove conclusively that though the air-brake pump is admirably adapted for the service which it was designed and is almost beyond criticism when on an engine, it is in the wrong place when compressing air for shop uses. If managers, purchasing agents, and others who wield the blue pencils that occasionally disfigure requisitions, could be made to realize these facts there would be more compressors purchased, for many officials in the mechanical departments who know the wastefulness of pumps cannot induce their managements to purchase compressors.

Before closing we might make a brief comparison between a compressor, with a capacity of about 18,000 cubic feet of free air per hour (a favorite size with some roads) and pumps of the same capacity. On the same basis as the previous comparisons, but assuming that the compressor can furnish a horse power on four pounds of coal, the annual fuel bill for the compressor would be $346 and of the pumps $1,500. This is not an ideal case, for we know of one company that had ten air pumps in its shops and now has in their place one large duplex compressor. The latter almost pays for itself in one year, with coal at only $1 per ton.

CAR WHEELS.

The notes on the Altoona shops, which will be found in another page, contain an account of some thermal tests and failures of cast-iron car wheels under the tests to which they were subjected, which probably add another cause of anxiety to the many which now haunt the minds of railroad men during their waking and probably sometimes their sleeping hours. It will also supply another argument to the makers and vendors of steel-tired wheels in favor of their wares, of which they will, doubtless, not be slow to avail themselves. In view of the experiments referred to, it may be said, interrogatively, that if a cast-iron wheel is cracked in a few seconds by contact with molten cast iron, how long will such wheels stand the application of brakes while descending a grade? It is true that cast-iron wheels are used less and less each year under passenger cars, and the Pennsylvania Railroad is one of the few great lines which still retains them in that branch of their traffic; but the company makes its own wheels, and, as was shown in the tests, those they make were not broken by the application of heat in the manner described. The danger to passenger trains is, however, not eliminated by confining the use of wheels which may be unsafe to freight trains alone. On all double-track roads there is always the possibility of terrible accidents if a wheel is broken under a freight train on a track adjoining another on which passenger trains run.

In view of this danger, it would be interesting to know whether the application of brakes, with the maximum pressure, when the wheels are revolving at their greatest speed, will have the same effect as the contact of melted cast iron had in the tests discovered. If so the inference cannot be escaped that wheels which will not stand such a test are dangerous.

Of course the steel-tired advocates will be prepared to show a ready way out of the difficulty, which will be the substitution of steel-tired wheels for those made of cast iron alone. But there are persons very competent to form an opinion on the subject, who contend that there are as many failures relatively of steel-tired wheels, as there are of those which are properly made of cast iron.

The figures contained in the last annual report of the British Board of Trade covering the year 1895 will have some bearing on this subject. For that year 454 failures of tires are reported in the United Kingdom. Of these it is said:

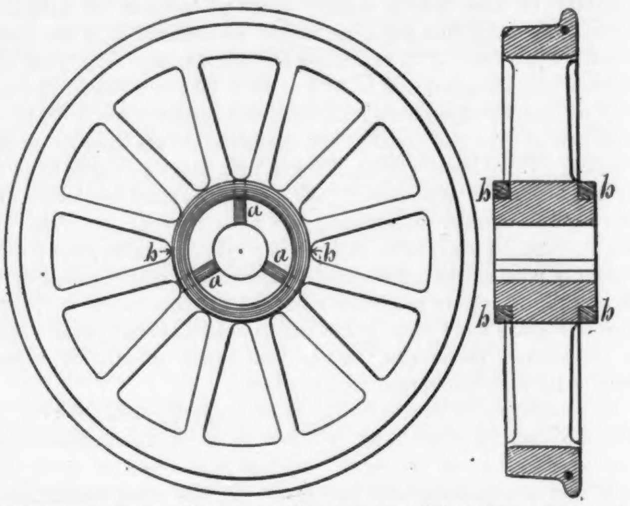
Twenty-one were engine tires, 8 were tender tires, 3 were coach tires, 17 were van tires and 405 were wagon tires; of the wagons, 309 belonged to owners other than railway companies; 268 tires were made of iron and 186 of steel; 12 of the tires were fastened to the wheel by Gibson's patent method; 11 by Mansell's patent method, 3 of which left their wheels when they failed; 3 by Beattie's patent method, 2 of which left their wheels when they failed; 91 by other methods, 50 of which left their wheels when they failed: 48 tires broke at the rivet holes, 1 in the weld, 154 in the solid, and 251 split longitudinally or bulged.

From these data it will be seen that the danger of breakage is not entirely removed by the adoption of steel-tired wheels, even when fastened with retaining rings; neither is it probable that steel-tired wheels will be generally substituted under our freight cars in the immediate future. It seems more likely—and it would appear to be a wise precaution—that railroad companies should specify that the wheels they use or buy should stand some such thermal test as has been described. The test has the advantage that if a wheel stands it it is not made useless thereby. It is not unreasonable, therefore, to expect that some railroad companies may require that several wheels in each 100 they receive shall be subjected to thermal tests, as well as to others which have heretofore been used. That it is possible to make wheels of the ordinary pattern—that is, with two curved plates next the hub and one inside of the rim and joined to the two inner ones, and with curved ribs or brackets in the back—which will stand the test was abundantly shown by the Altoona experiments. But, as is also pointed out in the notes, the experiments show clearly that all wheels are subjected to enormous strains when the rims or treads are heated. Probably the wheels which do not break when so tested are subjected to just as great strains, or at least deformations, as those are which fail, the only difference being that the material in some of them was capable of resisting such strains, whereas that in others was not.

In the design of the kind of wheels which were tested, the plates and the ribs are all made corrugated or curved, under a general impression that such forms will permit a slight amount of movement or deformation without rupture. That such forms are inefficacious in neutralizing the effects of expansion of the rims is indicated by the fracture of the wheels. In other words, those forms do not do what they were intended and were designed for. But is it not possible that some form could be designed which would permit the rims of wheels to be heated and expanded without causing a fracture? It is not easy to understand the nature of the strains which are produced in a wheel by heating its tread, nor how they cause it to fracture, transversely or radially. We have not heard of the experiment being made, but it would not be expected that a cast-iron tire would break transversely if its tread was heated by pouring melted cast iron around it, as was done in the wheel tests. It is proverbially dangerous to prophesy when a prophet is not sure of what will happen, and not having had the opportunity of making such an experiment, all that is asserted here is that we would not expect a cast-iron tire to break under such a test. Apparently what would occur, would be that the expansion would lengthen the ring of metal circumferentially and thus cause it to be enlarged in diameter. Now if we will imagine the inside of the tire to be tied to a central hub by an infinite number of fine radial wires in a state of tension—somewhat as the tire of a bicycle wheel is held—the expansion and consequent enlargement of the tire would apparently have a tendency to rupture the wires or break them by stretching. If the wires were strong enough to resist the tension caused by the expansion of the tire, then it would appear as though it would be subjected to a compressive strain in the direction of its circumference. Now, if instead of the wires we will imagine the tire cast solid on a central plate, as an ordinary wheel is made, then if the rim is heated the plate would be subjected to such radial strains as our hypothetical wires were assumed to resist, and it would again seem as though the rim would subjected to a circumferential strain of compression.

Or let it be imagined that a tire is fitted accurately to a cast-iron wheel center and is then heated. Obviously the effect will be to enlarge the tire diametrically and circumferentially and make it loose on its center. If it was cemented to the latter, apparently the effect of the expansion would be to break the cement or cause a circumferential fracture, which is what occurs where wheels are subjected to the thermal test described. What is not so plain is why the rim is broken transversely by heating it. If our wires, the cement between the tire or the center, or the plate were elastic, so that they could "give" radially, the strains which tend to break wheels circumferentially when their treads are heated would be relieved. The object of the corrugations in the plates and the curves in the ribs of ordinary wheels is to give this required elasticity. That these do not accomplish their purpose is shown by the tests which are here being commented on. What is needed seems to be greater radial elasticity or mobility in the plate of the wheel.

The generation of railroad men who are now playing the last act of their careers may remember how cast-iron wheels were made forty or fifty years ago. The following sketch, made from



memory, represents the kind which were made in what were considered large numbers by Ross Winans in his foundry in Baltimore.

As shown by the engraving, they were spoke wheels, the spokes being of rectangular section. The three shaded areas, *a*, *a*, *a*, in the hub were cored out, so that the hub of the casting was in three parts. Obviously this permitted the different parts of the wheel to expand and contract radially without straining any of them. After the wheel was cast, a steel drift, with a sharp cutting edge, was driven through the slots *a*, *a*, *a*, to remove the roughness of the castings. Wrought-iron plates were then driven in, and rings, *p*, *p*, were shrunk on the hub.

It seems as though a wheel made in that way would not be broken if tested in the manner herein described, which suggests the inquiry whether a form of wheel could not be designed which would have the same freedom to expand and contract that the Winans wheels had, and at the same time be without the obvious objections, which were inherent in that form of construction. It should be said here, that none of the parts of the hub of these wheels, excepting the bore, were machined. The shims *a*, *a*, *a*, rings *p*, *p*, and the bearings were all rough, and it was assumed would fit each other by some process of adaptation, which of course was very improbable. With modern appliances the openings *a*, *a*, *a*, could be slotted out, the outside of the hubs and inside of the rings *p*, *p*, could be turned with but little expense, and thus thoroughly good and reliable work could be done.

In the manufacture of these wheels Winans had considerable difficulty in getting sufficient chill in the throat of the flange, or where it joins the tread. To obviate this difficulty, he placed a wrought-iron ring made of round iron one-half or five-eighth inch diameter, in the mould, as indicated by the blank circles in the section. These rings were first filed bright so that the molten iron would adhere to them, and then anchored in the mould before the casting was made. This method of manufacture was employed for some years, but was finally abandoned, we believe

for the reason that the castings could not be made entirely sound in the vicinity of the rings.

Of course we are aware that numberless experiments have been made on cast-iron wheels, and that the number of forms which have been designed, proposed and patented is legion. Still improvement does not seem to be hopeless in this direction, as it is certain that the forms of wheel centers now used will not permit the parts to expand and contract without subjecting some of them to enormous strains.

At the Pittsburgh meeting of the American Institute of Mining Engineers, Mr. A. E. Outerbridge, Jr., of Philadelphia, read a very interesting paper with the title "The Mobility of Molecules on Cast Iron." In it he showed—on what seems to be conclusive proof—that under the influence of repeated shocks cast iron, instead of becoming brittle, as is ordinarily supposed, and weakened, has exactly the opposite effect produced by such treatment, and as a result of almost a thousand tests of bars of cast-iron of all grades, it was proved that it is materially strengthened by subjection to repeated shocks and blows. In view of the remarkable revelation which Mr. Outerbridge has made, it would be interesting to know whether cast-iron wheels which had been in service for a considerable time will stand the thermal test and other tests any better than new wheels do. It may be that eventually we will be obliged to subject such wheels to a sort of Swedish movement cure, or process of dynamic annealing, by subjecting them to a great number of repeated shocks in order to increase their strength. Those of an inventive turn of mind will readily conceive of a machine having a number of hammers acting radially, or in an axial direction to a wheel which would then be slowly revolved while it was subjected to an infinite or a great number of blows, to give the particles of the metal "mobility" and thus strengthen it and increase its capacity to resist thermal and other strains. In the language of patent specifications, "having thus fully described our invention, what we claim"—the reader can fill in.

THE VALUE OF A PATENT.

Our "esteemed contemporary," *Locomotive Engineering*, in its May issue, makes the following observations: "A patent has been obtained by Mr. M. N. Forney on a combination . . . of piston valve and cut-off, operated by a radial motion, which has a very close relationship to Joy's motion. We wish Mr. Forney much good luck out of his invention, but if he proposes to give a stock company the opportunity to boom the latest thing in valve-gear we must respectfully intimate that all our money is tied up."

That parties engaged in publishing two papers, one monthly and the other weekly should have "all their money tied up," is not a new phenomenon. In placing the stock of the new company, which our cotemporary intimates is about to be organized, none of it will therefore be assigned to the proprietors of the two papers, as other manufacturing enterprises seem to have absorbed all their spare cash, and they will thus lose the opportunity of "coming in on the ground floor." It has not yet been decided upon what basis the new patent will be capitalized, but due announcement will be made thereof. In the meanwhile we hope our cotemporary will not bear the market by detracting from the merits of the invention, and thus wrecking the company, which has not yet been formed. At present it is impossible to say "what there is in it for them," but if their silence cannot be secured in any other way, and as the senior editor of our cotemporary has had much secretarial experience, that position—without any salary—might be assigned to him as soon as a million of dollars of the stock is disposed of at par.

It is a curious fact that people without wit are apt to think that jokes are vulgar, and it is also true that men without ingenuity can seldom appreciate the value of a new and untried invention, which reminds us of a little story: Down in Pennsylvania a Dutch farmer had a dog which disturbed one of his neighbor's sheep. The neighbor shot the dog; whereupon suit was brought before a country "squire" by the owner to recover damages. When the case came up for a hearing the squire inquired—no pun intended—of the owner, with reference to the value of the dog. "Oh," the man replied, "he wasn't worth a dam. All I want is to make this man Fritz pay for him." Now it may be that the patent herein referred to is like the Dutchman's dog, and not worth a dam; but it is our infant, and we feel bound to defend it from such aspersions as our cotemporary has gently poured over it.

In the meanwhile, applicants for stock in the new company may address the Consulting Engineer of this paper.

TOLERANCE OF TOBACCO.

In the April issue of this paper we published an article which, to some extent, was an arraignment of the demerits of tobacco or the tobacco habit. Our "esteemed cotemporary," the *Railway Master Mechanic*, in an article on the same subject in the May number of that publication, dissents from the views which were advanced by us and which were then supported by much venerable authority. To the evil effects which were imputed to tobacco in our article, it seems, from our cotemporary's response, one more must be added, that of logical distortion, and it illustrates the truth of the Eastern proverb, that "reason is captive in the arms of the appetites as a weak man in the hands of an artful woman."

The writer referred to says the principal count in the indictment is that "tobacco is disagreeable to those who do not use it." In support of this, much testimony from wise, venerable and honored authorities was quoted. This our cotemporary discredits because the old worthies spelled execrably. Judged by this standard all wisdom which is more than a hundred years old must be discarded.

Our critic says that tobacco has the odor which the Lord gave it, and so has the onion, and therefore draws the inference that it is our duty to like both. The same observation will apply to the skunk. Our respondent says further that when persons are not endowed with a liking for such delectable perfumes that "the Lord makes up for the want by giving them other and special gifts and graces." Because woman don't like the smell of onions and tobacco she has been made good-looking. We are at present at a loss to know what is the special "gift" or "grace" with which our esteemed critic was endowed as a compensation for not enjoying the aroma of a pole-cat, whose perfume was nature's gift. It may be a source of satisfaction to beautiful women to know that they have been made so because they do not enjoy bad smells, but we would not advise our commentator to suggest to any of them such a reason for being good-looking, nor would it be judicious to solace any of the plain sisters by congratulations on their enjoyment of fetid odors.

He excuses the "universal and mighty craving" for tobacco by the fact that one "beautiful yearling deer, a few horses and some goats hanker after it." He adds further that the reason more beasts do not acquire the habit is that they have not the opportunity. In man only, he says, "the mighty instinct prevails." He should have spelled it *instinkt*, and then by inversion his argument concisely stated would be that the *instinkt* of smokers is stronger than that of beasts, which some of us are inclined to believe, but have not had the courage to state in its bald simplicity.

With reference to the Hottentot method of killing snakes by putting a drop of oil on their tongues, which our Chicago critic discredits, something should, perhaps, be said. Whether he suffers from snakes or not, we are not informed, but his familiarity with the methods of killing them is suggestive. We can assure him, however, that killing serpents by putting oil of tobacco on their tongues bears the same relation to the destruction of reptiles that the traditional salt deposited on their tails has to the catching of birds. We can assure him that if he is troubled with snakes, if he will only "catch them by the neck, force their jaws open and carefully deposit one drop of oil of tobacco on their tongues" and then live a sober and virtuous life, he will not be troubled with such varmints thereafter.

Our cotemporary sums up our argument by saying that we assume the attitude to others that "their tobacco is disagreeable to us, and, therefore, they ought not to use it." If he will modify this statement by the assertion that "when the use of tobacco is

offensive to others no gentleman will indulge in the habit," we will accept the statement as being all that can reasonably be contended for.

NOTES.

On the Lake Shore & Michigan Southern Railroad much attention has been given for some time past to the proper loading of freight cars and freight trains. At large terminals, particularly Buffalo, extensive transfers of freight have been made, and cars partially loaded received from other roads have not been hauled in that condition if it is possible to avoid it. The same care has been exercised in the loading of engines, and the result of all this work and the co-operation of the various departments interested has been a gratifying increase in the average carload and in the average trainload. In the annual report of the company for 1895 it is stated that while the ton mileage for that year was the largest in the history of the company, being 12.73 per cent. greater in 1894, the freight train mileage was decreased 5.42 per cent. (from 8,218,912 miles in 1894 to 7,773,337 miles in 1895), and this in connection with an increase in the average freight-train load from 267.2 tons in 1894 to 318.5 tons in 1895, is one of the chief causes of the gratifying results in the net earnings as shown in the 1895 report.

A form of built-up crank axle has been adopted for some classes of locomotives by Mr. F. W. Webb, Chief Mechanical Engineer of the London & Northwestern Railway of England. The object is to get more effective crank pin surface for the main rods, this surface being ordinarily considerably narrowed by the radii at each end. In the built-up shaft the crank pins and driving-box journals are casehardened. The section of the axle between the cranks has the four eccentrics forged on it.

The Committee on subjects for the 1897 Convention of the Master Car Builders' Association are desirous that members send to the Chairman a list of one or more subjects, which will, in their opinion, be desirable for committee work during the coming year. The Committee also ask for suggestions of subjects for topical discussions for the noon hours during the 1896 convention. Replies are to be sent to A. M. Waitt, General Master Car Builder, Lake Shore & Michigan Southern Railway, Cleveland, O., not later than June 1, 1896, but we would suggest that members who have not complied with the Committee's request can write now or seek out the members at convention, and their suggestions, though late, will be welcome.

Electric drills have ceased to be a novelty, but certain progressive electrical engineers are not content with what has been accomplished in this inviting field. The ordinary brace and rachet drill is relegated to the small shop. In English shipyards, says Engineering Mechanics, the electric motor is suspended by a rope and pulley, which has a counterweight that admits of movement up and down by the workmen. By easily-controlled mechanism the motor is steadied, and the drill can be worked 200 to 300 revolutions, but 70 to 100 is the average. The most ingenious device for driving drilling tools bores a series of holes one after another. In the electric drilling motor, as developed in some yards, each of its three legs is now an independent magnet, having a positive and negative pole. The face of each leg has three concentric spaces. The inner circle composes the negative pole, the outer ring the positive pole, a concentric portion between the two being filled with insulating material. Thus a perfectly steady tripod is afforded, and there is no danger of the drill breaking by its cutting unevenly through the plate. All these processes are as yet practically in their infancy, but it would seem as though the electric drill had a most important future. The system might be extended, with the aid of the tripod electro-magnetic contact, to slotting and planing, and we have little doubt that this will yet be accomplished. Messrs. Siemens have constructed portable electric motors, running at various speeds from 900 to 1,200 revolutions per minute; these motors being connected up to long flexible cables, associated with a powerful current from a dynamo, and being capable of rapid application to a vertical drill, which can be worked in any position within the radius provided by the length of the cables, and moved about from spot to spot as required.

As demonstrating the stability of lofty office buildings, the *Scientific American* quotes the results of a test recently carried out on the twenty-first floor of the American Surety Building, Broadway, New York, by the engineer and superintendent of the building, Mr. J. Turner. It was made during the height of a heavy storm which prevailed Jan. 4, when an official wind velocity of 82 miles per hour was registered in the neighboring station. The test failed to give the slighest evidence of vibration; a result which agrees with the testimony of the inmates that in a gale the topmost floors are as still as the first stories. The test was made with transit and level, and though it was not a test of the highest instrumental character, the result was remarkable, for both the plumb bob and the bubble remained perfectly still, even when the building was struck by the heavier gusts of wind.

In 1894 the jury of the section of Mechanical Industries at the Bordeaux Exhibition requested a test of the consumption of a Laval steam turbine of 100 horse power. Arrangements were made to measure the steam fed from a separate boiler, and two tests were carried out, one at the normal power of 98 horse power, the other at half load, 49 horse power. The consumption of steam was, working condensing: At full load, 32.23 pounds per kilowatt, 23.71 pounds per electric horse power, 20.15 pounds per brake horse power; at half load, 40.30 pounds per kilowatt, 29.65 pounds per electric horse power, 23.80 pounds per brake horse power. The efficiency of the dynamo used was taken at 85 per cent. at full and 80 per cent. at half load. A supplementary trial in the workshops of Messrs. Brégueton on a 74-horse power Laval steam turbine for electric lighting was also made. The steam consumption was measured by means of a surface condenser; and in a second trial, with a condenser giving a better vacuum. The object was to show that whatever the vacuum, the consumption, without reference to the work done, remains the same. The first trial lasted three hours. The vacuum was 21.6 inches for the first two hours, and 17.7 during the third; the steam consumption did not vary. In the second trial the vacuum was 25 inches, and the consumption of steam 32.47 pounds per kilowatt. These results prove that the quantity of steam used depends only on the steam pressure and the section of the pipe, and not to the exhaust pressure. If a steam turbine is meant to work economically with a small load, it is necessary to adjust the section of the orifice, and not the pressure of the steam by throttling. This is confirmed by an experiment made on a 10-horse power Laval steam turbine, without condensation, by Mr. Vincotte, Manager of the Belgian Steam Boiler Association. The consumption was 49.2 pounds at 9.7 horse power, and rose to 59.4 pounds at 6.5 horse power, and to 89 pounds at 3.31 horse power; by throttling the admission valve the pressure of the steam was very much reduced on entering the turbine.—*Inst. Civil Engineers—Foreign Abstracts.*

The Lehigh Valley Railroad Company put in service May 18 two trains of elegantly equipped cars for service between New York and Buffalo, which for completeness of detail and for comfort and safety are said to be unexcelled. These trains are to run daily, except Sunday, leaving New York and Buffalu, respectively, about noon, making fast time, and enabling those using the train to devote part of the day to business before the hour of departure, and at the same time offering an opportunity for viewing the scenery for which the Lehigh Valley Railroad is celebrated. The trains consist of a combination baggage, cafe and dining car coaches and an observation and parlor car, one of the features of the latter being a room for ladies, containing lounges, writing tables and easy chairs, with a library of current literature, together with the daily and weekly papers and magazines. Corresponding accommodations for men are found in the combination car, which contains a cafe, library, writing and smoking room. Some time ago General Passenger Agent Chas. S. Lee offered a reward of $25 in gold to the successful competitor who would suggest a name that should be finally adopted. The name

chosen is the "Black Diamond Express," and C. M. Montgomery, of Toledo, O., gets the $25.

The steadily increasing business of the Boston & Maine Railroad has necessitated increased shop facilities and a tract of several acres has been purchased just south of the business section of Concord, N. H., where it is the intention to erect shops at once. The plans of the company have not been made public, but it has been surmised that the new shops will be adapted not only for repair work, but also for the construction of cars and locomotives, a line of work not heretofore attempted on this road. The shops at Salem and Lawrence are to be retained.

Some of our readers may be interested in the details of the Sweeney brake, which is designed to utilize the cylinders of the locomotive as air pumps to fill the main reservoir of the brake system when the train is on a heavy grade. The details are few and simple. A 1¼-inch pipe is tapped into the steam chest cover and just outside of the casing a 1¼-inch plug cock is placed in the pipe. The pipe leads to the main reservoir and the plug cock is operated from the cab by a small rod and lever. Near the plug cock a 1¼-inch pop-valve is inserted in the pipe to prevent excessive pressure, and near the main reservoir a 1¼-inch non-return check valve is placed in the pipe to prevent air going out of the reservoir through this pipe. This comprises the whole apparatus. It has been reported upon very favorably by those using it in mountainous districts.

On the Union Pacific considerable trouble has been experienced with leaky joints in steam pipes in smokeboxes, and it is believed to be due in part to the thickness of the pipes. With a view of overcoming this trouble, Mr. McConnell has ordered a number of malleable iron pipes, the walls of which will be much thinner. The cast-iron pipes weigh 273 pounds, and the malleable iron ones weigh 148 pounds. The cost of the latter will be about the same as the former, the higher price per pound being offset by the lesser weight.

In a paper read before the Institution of Civil Engineers on the thermal efficiency of steam engines, Capt. H. R. Sankey advocated the comparison of engine performances with a standard thermal efficiency. He proposed as a standard the performance of an ideal engine, whose indicator diagram would be as follows: (1) Admission line at the temperature of the steam at the stop-valve of the engine; (2) expansion line adiabatic, and carried to within 0.15 atmosphere of the back pressure; (3) back pressure: that in the exhaust immediately outside the engine; (4) compression *nil*, and clearance *nil*. The object of limiting the expansion by carrying it down to within 0.15 atmosphere of the actual back pressure, instead of all the way down to the back pressure line, was to avoid encouraging the construction of engines too large for their work; if, on the other hand, the expansion in the standard were only carried to a pressure equal to the back pressure plus the mean pressure, corresponding with the fricton of the actual engine, a premium was, so to speak, awarded to the engine with large internal friction, and the standard would be made to vary with the friction of the actual engine. To avoid the lengthy calculation of the absolute thermal efficiency of the proposed standard, curves had been prepared enabling the required result to be obtained by inspection, and numerical examples were given to show the method of application.

The *Engineer* says: A well-known Middlesboro firm of iron merchants has just imported a quantity of pig iron from Alabama. It has, however, been brought over on very exceptional terms, the freight being little more than a merely nominal figure, as the iron was put in as stiffening to a cotton steamer. In the ordinary course the freight would prevent the importation of such iron except at a considerable loss. If the experience of another Middlesboro merchant firm is any criterion, this iron is not likely to be taken up by founders. The firm referred to last year imported some Alabama pig, and it is still on their hands in Liverpool, except a few sample lots. Consumers on this side have not taken kindly to it, as they say it does not suit their purposes.

Though the shops of the Delaware, Lackawanna & Western at Scranton have enough repair work to heavily tax their facilities, Mr. McKenna, the Master Car Builder, has managed to build thus far this year, sixteen new milk cars, two coaches and one mail car. The magnitude of the milk traffic on the road may be judged from the fact that the company has 111 cars devoted to this business. All passenger cars that are overhauled are fitted with vestibules and Gould platforms. If the cars are for through trains the vestibules are provided with side doors, but for local traffic they are omitted. For their through trains between New York and Buffalo the company is putting buffets in four coaches, one for each train, and the urns will be heated with Pintsch gas taken from the reservoirs under the cars. The same use of gas is made on the Wabash and New York, New Haven & Hartford roads.

The Lachine Rapids of the St. Lawrence are about to be utilized. For some time past work has been prosecuted on a large wing dam which runs out for more than 1,000 feet into the St. Lawrence River. A fall of water is secured by means of this dam, sufficient to develop at the low-water season about 15,000 horsepower. This water-power is to be transformed into electricity. Upon the dam a power-house will be built, which will run its entire length and show an unbroken interior of 1,000 feet in length. The basement of this will be occupied by water wheels. The main floor will contain the dynamos, of which there will be 12, each of 1,000 horse-power, or 12,000 horse-power in all. They will generate currents for transmission to Montreal for use there in lighting the city, operating the street railroads, and for any and all other lighting and power purposes.

A correspondent of the *English Mechanic* gives the following direction for oxidizing and blacking the bright work of steel in lieu of paint, to stand heat and to wear well: "Take 3 ounces of glacial acetic acid, mix it with its weight of water, to this add ½ ounce of powdered nut galls, and let stand for a day or two, shaking it up occasionally. Then let settle; then pour off the clear, then put a pint of boiling water to the residue. When cold and settled, pour off the clear and mix with the first. Now to this add a grain of nitrate of silver or sulphate of copper or nitrate of copper. Dissolve whichever you use in a little hot water before mixing with the other liquid. Silver is the best process. Clean all oil off and rust or scabs, paint, etc. Clean all up bright with pumice-stone powder. Don't use emery in any form, but the above with a piece of wood. Then clean all off; dry with air-slaked lime. Now go over it with the liquid with some cotton wool. If you have saved your powdered galls, take a little of that upon your wool, and will find that a great acquisition in the first application. Let stand until dry; then give it another coat. When dry, scratchbrush it, and give it another coat, etc. When you have got it to your liking, give it some linseed-oil and camphor. All bright iron parts can be made like ebony polished, and with the gun-metal mounting you will have a picture in black and gold. Cylinder covers, etc., can be done the same; but you must wash with hot water before oiling it. It will stand any amount of heat, the hammer and friction in wiping; you have no blistering, and you will have some difficulty in eradicating it. Bicycles, repairs, handle-bars, etc., can be treated the same way to advantage, well washed with hot water; when dry give them a coat of good copal carriage varnish."

A correspondent of the *Scientific American*, writing on raising of the lake levels, says there is much speculation over the utility of dams at the mouth of Lake Ontario and other lakes, but the plan will hardly be tried till something arises to make it appear feasible. It appears that the evidence is now to be had. The first vessel left Buffalo this season on April 20. There was at the time about 80 miles of ice to pass through before reaching open water. This ice disappears mainly through the action of the sun, but during the week, or perhaps fortnight, taken for it to disappear, large masses of it become detached and pass down the river. Naturally, this ice occasionally strikes the rocks at the head of the river, as the water is shallow, where it forms an imperfect dam. For some time the vessel men in the harbor noticed that the depth of water was subject to sudden variations.

An observation of the water line on the docks would show a rise or a fall of a foot or more in an hour or so. These changes were carefully observed now for the first time, as there was so much more dependent on the depth of water than usual at this time of year. The water level is materially affected by the wind, but there were changes of level that took place with no corresponding change of the wind, and it was at length found that whenever the ice field escaping into the river was caught on the shoal at the head of it the water rapidly rose and the vessels aground inside the harbor could be released. The main point of the showing seems to be the effectiveness of so frail and irregular a barrier as that formed by the ice, and, after that, the rapid rise of the water. But for the destructive force of storms and the flow of ice in spring, the showing is sufficient to prove that the dumping of ordinary stones, such as are constantly obtained from marine rock blasting, might be sufficient to solve the problem; and it is considered quite possible that these loose stones would remain several years without any cement or anchorage to hold them.

The conclusion reached by the correspondent from this action of the ice is that the proposed dams need not be nearly as complete and expensive as was supposed and that they will produce the desired result.

An enormous landslide occurred in the Himalaya Mountains on the northwestern frontier of BritishIndia in 1893, and, by damming up one of the tributaries of the Ganges, formed a lake which threatened great damage to the valley below when it should overflow. The mountain from which the slide occurred is 11,000 feet high, and the material came from a point 4,000 feet above the bed of the stream. The size of the barrier may be judged from the fact that it was 900 feet high, 3,000 feet long across the gorge on top, 600 feet long on bottom, and in cross-section was 2,000 feet at the top, and 11,000 feet at the bottom. The Government took in hand the task of reducing to a mininum the damage from the coming flood. Engineers surveyed the locality and determined by calculation the time when the lake would overflow, fixing a date that afterward proved to be within 10 days of the actual time. Telegraph stations were erected and maintained to warn the people in the valley and piers set in the hill sides 200 feet up from the stream to show them how far they must go to be safe. Other precautions were taken, such as removing steel suspension bridges and substituting temporary rope and wooden structures for them, and carrying out protective measures for the head works of a canal some 150 miles away. Various preparations were made for observations of the yielding of the dam, but it broke during the night (11:30 p. m.), when a heavy fog obscured everything, and by morning the level of the lake had fallen 390 feet. It is calculated that 10,000 million cubic feet of water was discharged in 4½ hours. In an account of the flood *Engineer* says that at the gorge immediately below the dam the flood rose to 260 feet over its ordinary level. The valley was filled up with huge blocks, and the bed of the river was raised some 234 feet, by a substantial weir with a long gentle slope stretching far down the valley. At 13 miles down, the river bed was raised 50 feet by the *debris* deposited, and the flood reached a height of 160 feet above its ordinary level. All down the valley, for fifty odd miles, the flood rose from 113 feet to 140 feet, causing serious damage. Even at Shrinugar, 72 miles from the landslip, the flood, which was first observed at 3:25 a. m., attained a maximum height of 42 feet above ordinary flood level. Here the damage done was great. The flood reached Hardwar, 150 miles from Gohna, at 8:45 a. m., on Aug. 26, and obtained a maximum height of 11 feet above the ordinary flood level. Fortunately, the main river was low at the time—lower, in fact, than at any time during the previous month. Had the extra Gohna flood arrived on top of one of the very heavy normal floods of the previous 30 days, the canal must have suffered grave disaster. As it was, considerable damage was done.

No lives were lost anywhere in the valley, excepting those of a fakir and his family who had twice been forcibly removed from his hut immediately under the dam and who persisted in returning to it. The self-imposed task of the Government cost it Rs.2,500,000.

The *Steamship* in its May number, in commenting on the increasing prosperity of the English shipyards, has the following to say about the shipping of other countries: France has made great efforts to encourage shipbuilding by granting bounties, but the result is a marked failure. She pays about £500,000 in bounties to shipping. Germany grants even more than this, but in her case the result is that her shipbuilding is being rapidly extended. At the present time all the yards in Germany are full of orders. Her merchant tonnage is now 1,300,000 tons, which is about double what it was ten years ago. Russia spends over £250,000 in shipping subsidies; her fleet is steadily increasing, but most of the ships are built in Great Britain. Italy pays over £100,000 in bounties, but her shipping and shipbuilding are declining. The United States is making headway in shipping and shipbuilding, and the Government is taking steps to foster the industry. The annual statistics of the Bureau Veritas relating to the mercantile navy of the world give the total number of sailing vessels now afloat, measuring over 50 tons, as 25,570, with an aggregate tonnage of 9,323,995 tons. Of this number, Great Britain comes first with 8,793 ships of 3,333,607 tons. The United States is second, with 3,824 vessels and 1,362,317 tons. Norway is third, with nearly one thousand fewer vessels than the United States, but nearly the same amount of tonnage. In regard to the steamers, England counts 5,771 vessels, with nearly ten million tons. Germany, which comes second, has 826 steamers of 1,306,771 tons. France comes third, with 501 steamers and 864,598 tons. The United States holds fourth place, with 447 steamers and 703,399 tons. These figures relate only to ocean and seagoing vessels, and do not include coasting craft or those employed in lake and inland navigation.

The Effect upon the Diagrams of Long Pipe-Connections for Steam Engine Indicators.*

BY PROF. W. F. M. GOSS.

Errors in indicator diagrams may arise from several causes, one of which is the pipe connecting the indicator with the engine cylinder. It is admitted that, under the conditions of ordinary practice, the presence of the pipe does not constitute the most prolific source of error, but it can be shown that it does cause serious distortion in the form of the diagram, and it is believed that this fact merits more careful consideration than has heretofore been accorded to it. The writer has already called attention to the fact that in road tests of locomotives, where the indicator is attached to a length of pipe sufficient to bring the instrument to the top of the valve box (a length of 3½ feet or more), a true card can be obtained only at slow speeds; and has shown that, for a speed of 300 revolutions per minute, the diagram is likely to be in error as much as 17 per cent.† These early experiments were further used as the basis of a discussion concerning the precise character of the influence exerted by the pipe. They have now been followed by a more extended series of experiments, the results of which are herewith presented.

All experiments were made in connection with a 7¾-inch by 15-inch Buckeye engine. The power of this engine was absorbed by an automatic friction brake, by means of which a very constant load was obtained. The head end of the engine cylinder was tapped with two holes (*a* and *b*, Fig. 1), both in the same cross section, and hence equally exposed to the action of the steam in this end of the cylinder. One of these holes (*a*) was made to serve for the indicator *A*, the cock of which was placed as close to the cylinder as possible. The hole *b* was made to receive one end of a U-shaped pipe, the other end of which entered a coupling fixed in the angle plate *c*. The cock of a second indicator, *B*, was screwed to this coupling. A single system of levers supplied the drum motion for both indicators. The closely-connected indicator, *A*, will hereafter be referred to as the "cylinder-indicator," and the cards obtained from it as "cylinder cards." It is assumed that this indicator recorded the actual conditions of pressure existing in the cylinder. In like manner the indicator *B* will be referred to as the "pipe-indicator," and cards obtained from it as "pipe-cards." It is assumed that this indicator gave a record which, when compared with that given by the cylinder indicator, demonstrated the effect of the pipe.

* Abstract of a paper read at the St. Louis meeting of the Amer. Soc. of Mech. Engineers.
† Proceedings of Western Railway Club, March, 1894, page 257.

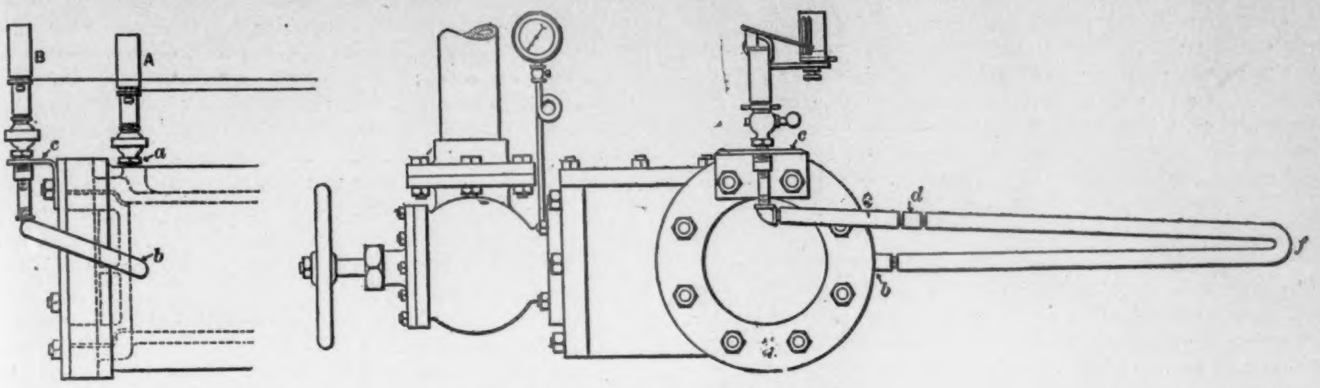


Fig. 1.—Method of Attaching Indicators.

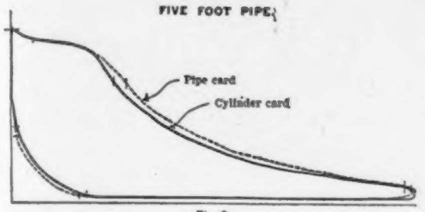


Fig. 2.

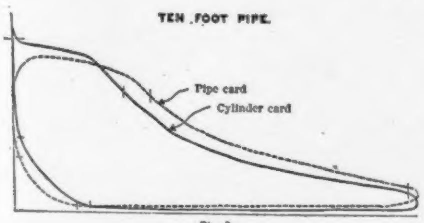


Fig. 3.

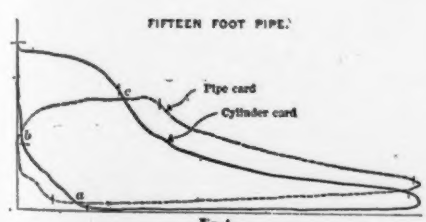


Fig. 4.

The speed (200 revolutions per minute), the steam pressure (80 pounds) and the cut-off (approximately ¼ stroke), were constant for above diagrams.

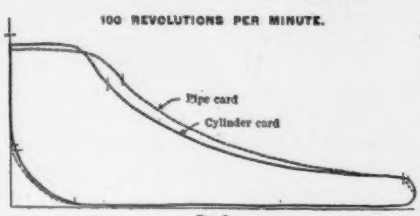


Fig. 6.

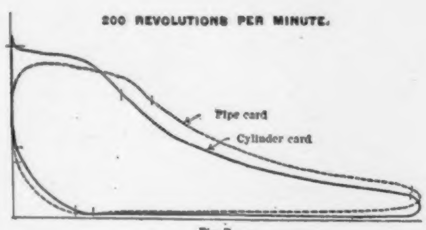


Fig. 7.

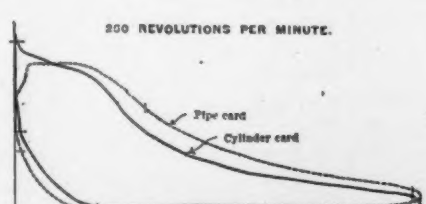


Fig. 8.

The steam pressure (80 pounds), the length of pipe (10 feet) and the cut-off (approximately ¼ stroke), were constant for above diagrams.

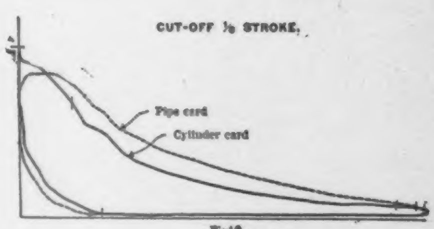


Fig. 5.

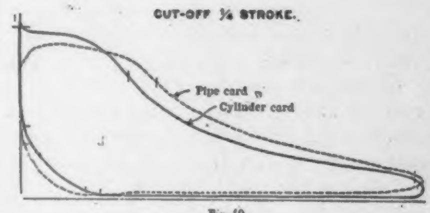


Fig. 10.

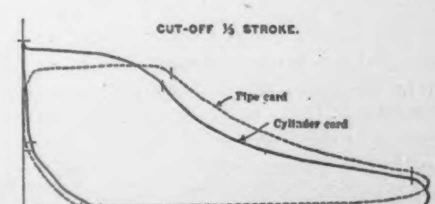


Fig. 11.

The cut-off as given above is approximate. The steam pressure (80 pounds), the speed (200 revolutions per minute) and the length of pipe (10 feet) were constant for above diagrams.

Comparison Between Pipe and Cylinder Cards at Various Speeds and Cut-Offs.

The pipe fittings were all half-inch. A right-and-left coupling at *d* allowed the U-shaped section *d f b* to be removed at will and replaced by a similar section of different length. Pipe lengths of 5, 10 and 15 feet were used, length being measured from the outside of the cylinder wall to the end of the coupling under the cock of the pipe-indicator. The pipe and fittings were covered first with a wrapping of asbestos board, next with three-eighths of an inch of hair felt, and finally with an outside wrapping of cloth. It is to be noted that the bend in the pipe at *f* is easy, and that there is a continual rise in the pipe in its course from the cylinder to the indicator. New Crosby indicators were used and were always well warmed before cards were taken.

The results, which are presented in the form of diagrams (Figs. 2, 3, 4, etc.), were obtained in the following manner:

The engine having been run for a considerable period, and the desired conditions as to pressure, speed and cut-off having been obtained, cards were taken simultaneously from the cylinder and the pipe-indicator. Two pairs of cards (*i. e.*, two from cylinder and two from pipe) were thus taken as rapidly as convenient, after which the position of the indicators was reversed, and the work repeated. There were thus obtained four cylinder-cards and four pipe-cards, one-half of each set having been made by one of the indicators, and one-half by the other. Next, by the use of closely drawn ordinates the eight cylinder-cards were averaged and combined in the form of a single card, and the eight pipe-cards were in the same way combined to form a single pipe-card. The two typical cards thus obtained, superimposed as in Fig. 2, constituted the record of the test. This process was repeated for each of the several conditions under which tests were made. It is proper to add that the accuracy of the indicators used, and the constancy of the conditions maintained, were such as to make each card almost, if not quite, the exact duplicate of the representative of its set.

The diagrams presented are two-thirds size, the spring for all being 60 pounds.

ANALYSIS OF RESULTS.

Different Lengths of Pipe.—The effects produced by the use of pipes between the indicator and the engine cylinder, of five, ten and fifteen feet in length, are shown in Figs. 2, 3 and 4 respectively, the speed, steam pressure and cut-off being constant.

By reference first to Fig. 2, it will be seen that the effect of a five-foot pipe is to make the indicator attached to it a little tardy in its action. Thus, during exhaust, when for a considerable interval of time the change of pressure to be recorded is slight, the lines from the two indicators agree; but during the compression which follows the loss of sensitiveness in the pipe-indicator is made evident by its giving a line which falls below the corresponding

line traced by the cylinder-indicator. Similarly, during admission there is an approximate agreement, while during the expansion which follows the lagging of the pipe-indicator results in a line which is higher than the expansion line given by the cylinder-indicator. As a result of this lagging in the action of the pipe-indicator, its card is in error in the location and curvature of the expansion and compression curves; also in the location of the events of the stroke and in the area which it presents. The speed at which these errors are shown to occur is moderate (200 revolutions), and the length of pipe attached to the indicator is not greater than is often used.

The general effect of a 10-foot length of pipe (Fig. 3) is the same with that of the shorter length, but the lagging action due to the pipe is more pronounced, and all errors are proportionately greater. The total range of pressure recorded upon the cards is less than the range existing in the cylinder.

A still further addition to the length of the pipe brings changes (Fig. 4) into the form of the pipe-card diagram which, while entirely in harmony with those already discussed, are of such magnitude that the form of the card loses some of its characteristic features. The admission and expansion lines are lower, and the exhaust line is higher, than are the corresponding lines for the true card. Furthermore, while cards from pipes of five and ten feet in length present an area greater than that of the true card, the card from a 15-foot length of pipe makes the area less. It is evident that a pipe of suitable length would result in a diagram somewhat similar in form to that shown by Fig. 5; a pipe still longer would give a card which would be represented by a single line, as *AB*, Fig. 5.

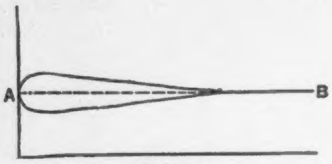


Fig. 5

It is true that the lengths of some of the pipes experimented with are excessive as compared with those commonly used for the connection of indicators, but this fact does not deprive the results of their significance. If pipes of fifteen, ten and five feet in length will produce the effects shown by Figs. 4, 3 and 2, respectively, it is but reasonable to suppose that pipes of less than five feet in length will produce some effect. And, since the effect of a five-foot pipe is considerable, this length must be greatly reduced before the effect ceases to be measurable.

[The author next explains the cause of the slight differences in form between the cylinder diagrams taken under the same conditions. These are attributed to changes in clearance produced by the different lengths of pipes leading to the other indicator, the greater surfaces exposed to the steam in the longer pipes, and to the flow of steam in and out of these pipes. He concludes that the existence of these differences in the cylinder diagrams does not in any way affect the results the paper is designed to present. Each cylinder card is true for the conditions under which it was taken.]

The Effect of the Pipe at Different Speeds.—The effects thus far discussed are those recorded for a constant speed of 200 revolutions per minute. In considering to what extent changes of speed will modify these results, reference should be made to Figs. 6, 7 and 8, which give a series of results for which all conditions were constant except that of speed. It will be seen that increase of speed produces modifications in the form of the pipe-diagrams which, in kind, are similar to those produced at constant speed by increasing the length of the pipe, but these changes are not great. For example, increasing the speed from 100 to 200 revolutions per minute (Figs. 6 and 7) produces less change than increasing the length of the pipe from 5 to 10 feet (Figs. 2 and 3). The fact that an engine runs slowly, therefore, does not seem to justify the use of an indicator at the end of a considerable length of pipe. Slow running reduces the error; it cannot be depended upon to eliminate it entirely.

The Effect of the Pipe at Different Cut-Offs.—The relative effect of the pipe at different cut-offs, other conditions being constant, is shown by Figs. 9, 10 and 11. It will be seen that the differences of pressure recorded during expansion by the two indicators (pipe and cylinder) are approximately the same for all cut-offs; but the relative effect of these differences upon the area of the diagram is most pronounced upon the smallest, or shortest, cut-off card. The fact that in Fig. 11 the steam line on the pipe-card rises while that of the cylinder-card declines, constitutes a good illustration of the slowness with which the pressure in the pipe responds to that in the cylinder. The following conclusions constitute a summary of the data already presented:

1. If an indicator is to be relied upon to give a true record of the varying pressures and volumes within an engine cylinder, its connection therewith must be direct and very short.
2. Any pipe connection between an indicator and an engine cylinder is likely to affect the action of the indicator; under ordinary conditions of speed and pressure, a very short length of pipe may produce a measurable effect in the diagram, and a length of three feet or more may be sufficient to render the cards valueless except for rough or approximate work.
3. In general, the effect of the pipe is to retard the pencil action of the indicator attached to it.
4. Other conditions being equal, the effects produced by a pipe between an indicator and an engine cylinder become more pronounced as the speed of the engine is increased.
5. Modifications in the form of the diagram resulting from the presence of a pipe are proportionally greater for short cut-off cards than for those of longer cut-off, other things being equal.
6. Events of the stroke (cut-off, release, beginning of compression) are recorded, by an indicator attached to a pipe, later than the actual occurrence of the events in the cylinder.
7. As recorded by an indicator attached to a pipe, pressures during the greater part of expansion are higher, and during compression are lower, than the actual pressures existing in the cylinder.
8. The area of diagrams made by an indicator attached to a pipe may be greater or less than the area of the true card, depending upon the length of the pipe; for lengths such as are ordinarily used, the area of the pipe cards will be greater than that of the true cards.
9. Within limits, the indicated power of the engine is increased by increasing the length of the indicator pipe.
10. Conclusions concerning the character of the expansion or compression curves, or concerning changes in the quality of the mixture in the cylinder during expansion or compression, are unreliable when based upon cards obtained from indicators attached to the cylinder through the medium of a pipe, even though the pipe is short.

Bechem & Post's System of Water-Spray Firing.*

BY ADOLPH BECHEM.

A water-spray ventilator, manufactured by Mr. F. Kluge, of Barmen, having been adapted to a soldering stove, it was observed that the fire became so fierce that a soldering-tool placed in it speedily became partially melted. The draught in the case of a smith's forge provided with this spray-ventilator produced a much greater heating effect than had previously been obtained by means of a Root's blower with a manometric pressure equal to 15.7 inches of water; the equivalent draught with the water-spray ventilator being only 0.12 inch. The author was led, on this account, to attribute the rise in temperature to the decomposition of the minute globules of water and the combustion of the resultant gases. He accordingly purchased Mr. Kluge's patent for firing purposes. Attention is directed to the various ways in which water can be employed as fuel and its use in the production of so-called water gas. When utilized as steam in the form of the steam-jet, water is much less effective as fuel in consequence of the fact that one molecule of water occupies the space of 1,700 molecules of steam, and thus the chemical energy of steam is only the $\frac{1}{1700}$ part of that of water. The peculiar value of the water-spray as fuel lies in the fact that the finely divided drops of water come into far more intimate contact with the carbon on the hearth than the more elastic particles of steam and, moreover, as air is needed to support combustion, and as steam is at even temperatures specifically much lighter than air, there is, in the case of the steam-jet, a tendency on the part of the steam to separate itself from the atmospheric air, to rush forward to the fuel, and to prevent the free access of air to the carbon. Experiments with various kinds of fuel—coal, coke, etc.—in a smith's forge, have demonstrated that the water-spray is capable of producing the highest possible temperatures; the special arrangement of the jet for this purpose are explained. The use of the water-spray under fire-bars is extremely beneficial, as they are thereby kept cool and become rapidly protected by a coating of oxide, which serves as a preservative; there is, moreover, scarcely any perceptible waste in the bars. Experiments have also been made with the use of the water-spray on a large scale for blast furnaces and other manufacturing purposes, and it is also capable of being used under certain conditions in domestic stoves.

The air-pressure needed to produce the spray is very moderate, even that due to water at a height of 33 feet suffices. The amount

* Abstract in *Proceedings* of Inst. of Civil Engineers of article in *Gesundheitz-Ingenieur* of July 31, 1895.

of water which can be consumed in the spray form varies, of course, with the size of the fireplace from two to six gallons per hour.

The advantages of this system of firing are thus summed up by the author: Great economy of fuel, absolute freedom from smoke, immediate production of extreme temperatures up to the melting point of platinum, adaptability of every description of fuel for the purpose, applicability of the system to all kinds of firing needed for industrial and domestic operations, and, lastly, the possibility of replacing by this means all existing regenerative systems and all plant adapted for firing with powdered coke, coal, etc.

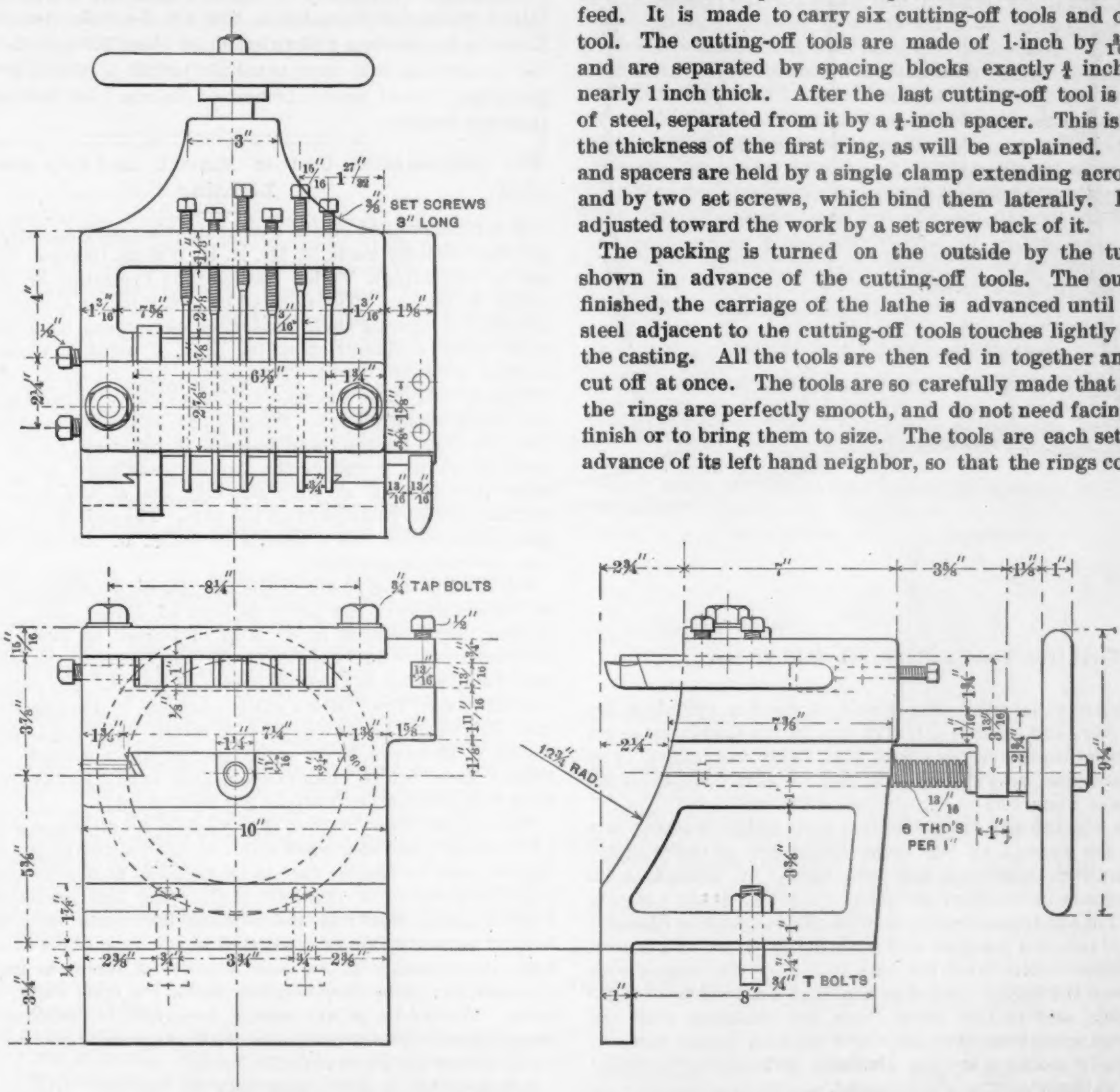
[These experiments seem to have a very important significance. There is a popular impression among firemen, which is very general, that wetting coal improves combustion. Besides doing this, it serves the purpose of preventing dust, and with very fine coal of coagulating the particles of coal until they reach the fire, and thus prevent them from being carried through the tubes and up the chimney by the draft. Some experiments have recently been made by a chemist, who took the purest oxygen and carbon which he could obtain, from both of which all moisture was extracted. When these were perfectly dry, it was found to be very difficult to make them combine, showing that a certain amount of moisture was required for combustion. It would be very interesting—and probably very profitable—if an investigation were made to establish the correctness of the conclusions reached in the article quoted above, and to determine under what conditions and in what quantities water-spray will improve combustion. It may be that this idea is of practical value.—EDITOR AMERICAN ENGINEER.]

Multiple Tool Post for Turning and Cutting-off Piston Packing.

The excellent practice of comparing costs of work in the various shops of the same railroad system led indirectly to the design of the multiple tool holder for turning and cutting-off packing shown herewith. In making such comparisons on the Chicago, Milwaukee & St. Paul system it was found that piston packing was produced at some of the shops for less than it cost at the West Milwaukee shops. Not to be outdone, the tool shown was designed for the work, and as a result packing for an 18-inch engine is turned out at a total cost for labor of 23 cents.

The tool holder is of special form and is mounted on the carriage of the lathe just ahead of the regular tool holder and well out toward the apron. It is provided with a transverse hand feed. It is made to carry six cutting-off tools and one turning tool. The cutting-off tools are made of 1-inch by $\frac{3}{16}$-inch steel and are separated by spacing blocks exactly $\frac{3}{4}$ inch wide and nearly 1 inch thick. After the last cutting-off tool is a plain bar of steel, separated from it by a $\frac{3}{4}$-inch spacer. This is for gaging the thickness of the first ring, as will be explained. These tools and spacers are held by a single clamp extending across them all and by two set screws, which bind them laterally. Each tool is adjusted toward the work by a set screw back of it.

The packing is turned on the outside by the turning tool shown in advance of the cutting-off tools. The outside being finished, the carriage of the lathe is advanced until the bar of steel adjacent to the cutting-off tools touches lightly the face of the casting. All the tools are then fed in together and six rings cut off at once. The tools are so carefully made that the sides of the rings are perfectly smooth, and do not need facing either for finish or to bring them to size. The tools are each set slightly in advance of its left hand neighbor, so that the rings come off one at a time and give the operator time to take care of them. After cutting off one group of six, the cutting-off process can be immediately repeated without facing off the end of the casting remaining on the face plate. The rings are left rough on the inside.

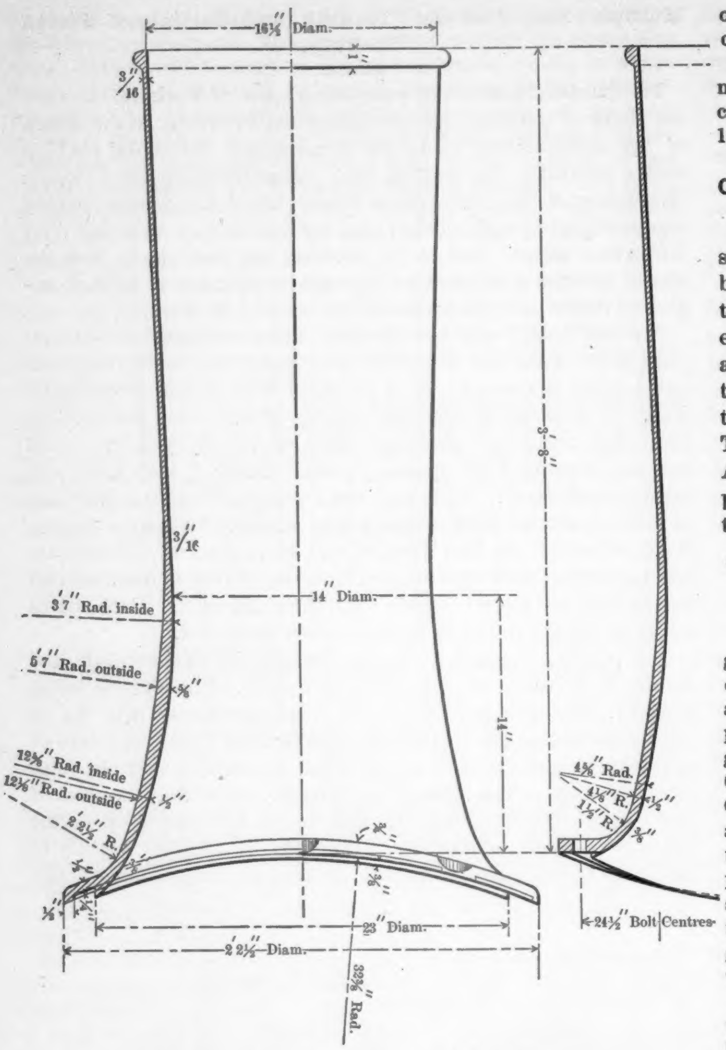


Multiple Tool Holder for Turning and Cutting Off Piston Packing Rings.

Quadruple-Expansion Marine Engine.

A somewhat novel departure in marine-engine practice, which will, no doubt, be followed with interest, has just been made by the Central Marine Engine Works of Messrs. William Gray & Company, Limited, of West Hartlepool, in the design of engines which they have fitted to the new steamer *Inchmona*, recently built by them to the order of Messrs. Hamilton, Fraser & Company, of Liverpool.

In the engines under notice there are five cylinders, the two low-



Cast Iron Smoke Stack.—C. & N. W. Ry.

pressure being of equal size. The whole of the five cylinders are arranged in line, and connected to five cranks, the cranks being set at equal angles throughout the circle, i. e., 72 degrees apart. The cylinders are respectively 17 inches, 24 inches, 34 inches, 42 inches and 42 inches in diameter.

The steam for the engines is supplied from boilers working at a pressure of 255 pounds on the inch. These are of the ordinary cylindrical multi-tubular type, and were tested by Lloyd's to 510 pounds per square inch. They are fitted with Mr. Mudd's system of superheating apparatus, combined with the well-known Ellis and Eaves' type of induced draught, and with Serve tubes and retarders. An attempt is here made not only to supply the engine with dry steam from the boilers, but to retain it in a dry state throughout the engine; and to this effect there are combined with the superheater an apparatus that Mr. Mudd calls an initial receiver, an exceptionally complete system of steam jacketing to the cylinders, and an exhaust control arrangement.

There is also an unusually elaborate scheme of feed heating. Instead of the usual single vessel, there are a series of feed heaters worked at graduated temperatures, and as the water passes through these it continues to rise in temperature until on entering the boilers it is nearly at the temperature of the steam. On the trials the thermometers registered about 400 degrees Fahrenheit as the temperature of the feed water as it passed the meter and entered the boilers. The feed-water filters are the Edminston patent, and Mudd's evaparator is used.

The five-crank system does not, as might be supposed, involve any great increase in length of engine-room space, as the reduced diameters of cylinders allow the centers to be closer. In the case of the *Inchmona*, the engine-room is only one frame space longer than for the same power in three-crank engines. The five-crank principle is put forward by the builders as most suitable for large powers and for long-voyage boats, where economy of fuel is of such vital importance. If the predictions of the builders are realized it will mean that some 500 or 600 tons of coal can be saved on the single round voyage to Australia or New Zealand of a cargo boat carrying 6,000 or 7,000 tons, at a speed of eleven knots. The designers of the engines confidently anticipate that, by means of the various improvements effected, the consumption of coal will be brought down to a figure closely approximating to 1 pound per I. H. P. per hour.—*The Practical Engineer.*

Cast Iron Smoke Stack—Chicago & Northwestern Railroad.

In the accompanying drawing we show the standard cast-iron stack of the Chicago & Northwestern Railroad. The stack and base are all in one casting with the holes cored for securing it to the smokebox, so that there is no labor whatever expended on it, except to put it in place and paint it. Three patterns suffice for all engines. A single pattern is used for stacks of various lengths, the diameter at the base and throat and the taper being maintained while the diameter at the top depends upon the length. The stacks average somewhat more than 300 pounds in weight. As the castings cost three cents per pound (a special price for this particular line of work) the cost of the stack on the engine is less than ten dollars.

The Comparative Cost of Pintsch and City Gas for Car Lighting.

A valuable report on the cost of lighting passenger cars with city gas was recently made to Mr. R. H. Wilbur, General Superintendent of the Lehigh Valley Railroad, by Professors W. H. Chandler and J. E. Denton. The railroad company had in contemplation the problem of lighting their passenger equipment with gas, and had given some consideration to the plan of using city gas, burned in Gordon-Mitchell lamps. The Safety Car Heating and Lighting Company had made the road a proposition to furnish a generating and compressing plant for Pintsch gas, at Phillipsburg (just across the river from Easton), and operate it, covering all labor and expense necessary to charge the cars with sufficient gas to afford the same illumination as with the city gas, at the rate of $5.09 per thousand cubic feet stored on the cars. The object of the investigation and report was to determine which of the two propositions was the more economical.

The illuminating power of the city gas obtainable at Phillipsburg was assumed to be the same as that of Jersey City, which when burned uncompressed in an Argand burner at about 60 degrees Fahrenheit gave 5.22 candle power per foot. In the same burner, after compression to 17 atmospheres, it lost 54.2 per cent. of illuminating power. The Pintsch gas compressed by the experimenters at the Delaware, Lackawanna & Western Railroad Company's gas works, at Hoboken, to 12 atmospheres, when burned in the same burner, gave before compression 10.25 candle power per foot, and after compression lost only 4.4 per cent. of light.

The city gas when burned in Gordon-Mitchell lamps at the rate of 7.6 cubic feet, per hour gave about 29 candle power per lamp at 45 degrees, and for the 174 cars to be supplied at Easton and Phillipsburg there would be required 18,872 cubic feet per 24 hours. The Pintsch gas if burned in the Pintsch four-flame lamp or in their Argand burner would be consumed at the rate of 3.4 cubic feet per hour, consequently in the same number of lamps as used for the city gas the total consumption would be 8,443 cubic feet per 24 hours. The candle power would, however, be considerable more, being 54 candle power per lamp for the Argand burner and about 35 candle power for the four-flame lamp.

A comparison is first made between the two systems upon the basis of a consumption of 18,872 cubic feet of city gas and 8,443 cubic feet of the Pintsch gas. The lowest cost of compressed city gas at Easton is given at $2,883 per thousand, as follows:

LOWEST COST OF COMPRESSED CITY GAS AT EASTON FOR CONSUMPTION BY LAMPS OF 18,872 CUBIC FEET PER 24 HOURS.

Average of Summer and Winter Consumption.

Coal for compressing, at $1.75 per gross ton..........	4.25c.	per thousand.
Water for compressing, at $1.00 per 1,000 cubic feet..	1.19c.	" "
Labor for filling cars and compressing..............	47.27c.	" "
Material for repairs of charging system............	14.40c.	" "
Interest and depreciation on cost of compressing plant..................................	17.50c.	" "
Interest and depreciation on extra investment for car tanks using city gas over that required for tanks using Pintsch gas..........................	15.65c.	" "
Cost of city gas equivalent to Jersey City gas delivered to compressing stations at $1 50 per M, including extra cost due to unavoidable loss by leakage between compressor and cars of 20 per cent. of total gas................................	188.00c.	" "
Total cost of city gas on cars at 270 pounds pressure..	$2.883	" "

The items comprising the above statement were obtained as fol-

lows: The size of the compressing plant needed was first determined. In compressing the gas to 20 atmospheres and delivering it on the cars actual tests demonstrated there would be a loss through leakage and liquefaction of 20 per cent., of which 14 per cent. was for leakage alone. In a compound or two-stage compressor (which is the type recommended for the work) actual tests show the delivery of gas at 20 atmospheres does not exceed 57 per cent. of the piston displacement.

It was further found by observation at a point where about 100 cars are charged every 24 hours and 22,000 cubic feet of gas pass through the compressors that two-thirds of the gas is compressed during the day, and also that the maximum demand upon the compressors is about twice the average for the daylight hours. Taking all these facts into consideration, the required piston displacement of the compressors is found to be about 5,000 cubic feet per hour and two compressors of 2,500 cubic feet are recommended. These would run at 75 revolutions, but could be speeded up to 150 in emergencies. The price of each compressor is placed at $850 and the total cost of the compressor plant is given as follows.

Two compressors at $850	$1,700
Connections	50
Foundations	50
Labor of erecting	50
Building	244
Total	$2,094

Tests of a similar gas compressor showed that the indicated horse power per 1,000 cubic feet piston displacement at 20 atmospheres per hour was about 3.8 horse power. To displace at the rate of 2,500 cubic feet would therefore require 9.5 horse power. To pump from one storage reservoir into the others at the same rate would probably require 50 per cent. as much power, or 4.75 horse power, which added to the other would give a total of 14.25 horse power. Experiments show that 45 pounds of water must be evaporated per horse power to 60 pounds pressure, or 641 pounds of steam per hour. This would necessitate a boiler of about 22 nominal horse power with 10 square feet of grate and 300 square feet of heating surface, costing $300 set up and connected; adding $250 for the building makes the total cost of the boiler plant $550. If the company's boilers already at Philipsburg can supply the steam this item can of course be omitted.

The storage capacity at the compressing station is taken at a figure large enough to charge a Buffalo train of three coaches and two sleepers at Easton in ten minutes, without interrupting the charging of cars in the yard. The Buffalo train would require 2,736 cubic feet and to charge a train of three coaches in the yard that were three-quarters exhausted would require 776 cubic feet. If such a train had to be charged within 20 minutes after the Buffalo train the total gas required in that period of time would be 3,512 cubic feet. Of this amount the compressors could pump in that time 1,000 cubic feet, leaving 2,512 cubic feet to be supplied from the reservoirs. To do this the reservoirs must have a capacity of 1,256 cubic feet. Five reservoirs 50 inches in diameter and 20 feet long would suffice, and their cost would be as follows:

Five reservoirs	$4,000
Valves and fittings	1,250
Foundations and shed (to protect reservoirs from sun heat)	300
Labor of erection	100
Total	$5,650

The pipe lines necessary to charge cars at Phillipsburg and Easton are computed to cost $2,972.

The cost of extra tank storage on the cars to hold the greater volume of city gas is given at $55 per car with five lamps, or for 174 cars $9,570. This estimate is based on one tank of 18.6 cubic feet capacity for Pintsch gas, containing enough gas for 14 hours' consumption, and two tanks of 14.5 cubic feet capacity for the city gas.

Combining the above items, the total investment for the use of city gas is found to be as follows:

Compressors, buildings and foundations for same	$2,094
Boiler, erected and housed	550
Storage reservoirs, erected and housed	5,650
Pipe lines and charging-fittings, in place	2,972
Investment for compressing plant	$11,266
Additional cost of car-tanks for 14 hours burning supply, using city gas, over that with Pintsch gas	9,570
Total investment	$20,836

The cost of operation was investigated in the same careful manner. It was found that the coal burned per 1,000 cubic feet of gas compressed for the lamps was 54.4 pounds, which at $1.75 per gross ton cost 4.25 cents per thousand. The water per thousand feet of gas compressed was 11.9 cubic feet, including jacket water for the compressor cylinder, which at $1.00 per thousand cost 1.19 cents.

The labor at the compressors and boiler house is placed at 21.46 cents per thousand feet if a separate boiler plant was required, and 19.37 cents if steam was taken from other boilers. For filling the cars it was found in another yard, where about 25,000 cubic feet is made per 24 hours, it was found that 3 day men working 12 hours at 14 cents per hour, and one night man working 12 hours at 11 cents per hour, were needed in winter. In summer 2 day men at 14½ cents and one night man at 11 cents did the work. Other yards were examined, and it was concluded that one day and one night man would be required at Easton, and one day man at Phillipsburg all the year round, making the cost of labor for filling 24.8 cents per thousand in winter, and 31 cents in summer (when the consumption would be 20 per cent. less than in winter) or an average of 27.9 cents throughout the year.

The cost of material for repairs was determined from the records of the Safety Car Lighting and Heating Company, no railroad records being available. It was found to be 14.4 cents per thousand.

Interest was taken at 6 per cent. and depreciation at 4 per cent., amounting to 18.41 cents if the separate steam boilers had to be used and 17.5 cents if they were not installed. The interest and depreciation on the extra tanks needed on the cars for the city gas must be added to this, it being 15.65 cents.

The city gas can be obtained at $1.50 per thousand feet from the city mains, but the loss from leakage and shrinkage already noted brings the cost per thousand feet actually consumed to $1.88.

We have now given the derivation of all of the items mentioned in the table, showing the total cost of the city gas on cars as $2.883 per thousand. The illuminating qualities of the two gases are next summarized in the following table:

RESUME OF ALL ILLUMINATING TESTS.

Relative Illumination per Cubic Foot of Gas Burned.

Candle power per cubic foot: Candle power with Gordon-Mitchell lamp, burning city gas at the rate of 7.6 cubic feet per hour, affording about 29 candle power at 45 degrees.

Tests in which photometer-disc was at equal distances from floor of car in tests of four lamps.

Lamp compared.	Cubic feet of gas per hour.	Candle power at 45 degrees.	Relative illumination per cubic foot of gas burned. Tests with single.	Tests with four.	Average.
1.	2	3	4	5	6
1. Gordon-Mitchell lamp, burning Pintsch gas	3.36	26.0	2.07	2.06	2.06
2. No. 1 Pintsch Argand lamp, burning Pintsch gas	3.41	54.3	4.42	3.76	4.09
3. No. 1 Pintsch Argand lamp	7.13	30.4	1.22	0.98	1.10
4. Four-flat-flame Pintsch lamp, burning Pintsch gas*	....	.	3.12	2.73	2.92
Average	3.31	35.4	Aver. 3.02		Aver 2.87
5. Four-flat-flame Pintsch lamp, burning Pintsch gas*	....	....	2.92	2.73	2.82

Tests in which photometer-disc was at equal distances below the lamp flame centres in tests of four lamps.

Lamp compared.	Cubic feet of gas per hour.	Candle power at 45 degrees.	Tests with single.	Tests with four.	Average.
6. Gordon-Mitchell lamp, burning Pintsch gas	3.36	26.0	2.07	2.16	2.11
7. No. 1 Pintsch Argand lamp, burning Pintsch gas	3.41	54.3	4.42	3.44	3.93
8. No. 1 Pintsch Argand lamp, burning city gas	7.13	30.4	1.22	0.89	1.05
9. Four-flat-flame Pintsch lamp, burning Pintsch gas*	....	....	3.12	2.50	2.81
Average	3.31	35.4	Aver. 3.02		Aver 2.76
10. Four-flat-flame Pintsch lamp, burning Pintsch gas†	....	....	2.92	2.50	2.71

In tests marked * the four-flat-flame Pintsch lamp was set so that each of the four flames are at an angle of 45 degrees to a vertical plan was passing through the centre of the lamp and of the photometer-disc.

In tests marked † the lamp was set so that one of the four flames was toward, and parallel to, a vertical plane passing through the axis of the photometer-disc.

The following conclusions are drawn from the data presented above:

I. If 1,000 cubic feet of Pintsch gas was burned in the Pintsch Argand lamps while the latter afforded the illumination corresponding to about 54 candle power for a certain number of burning

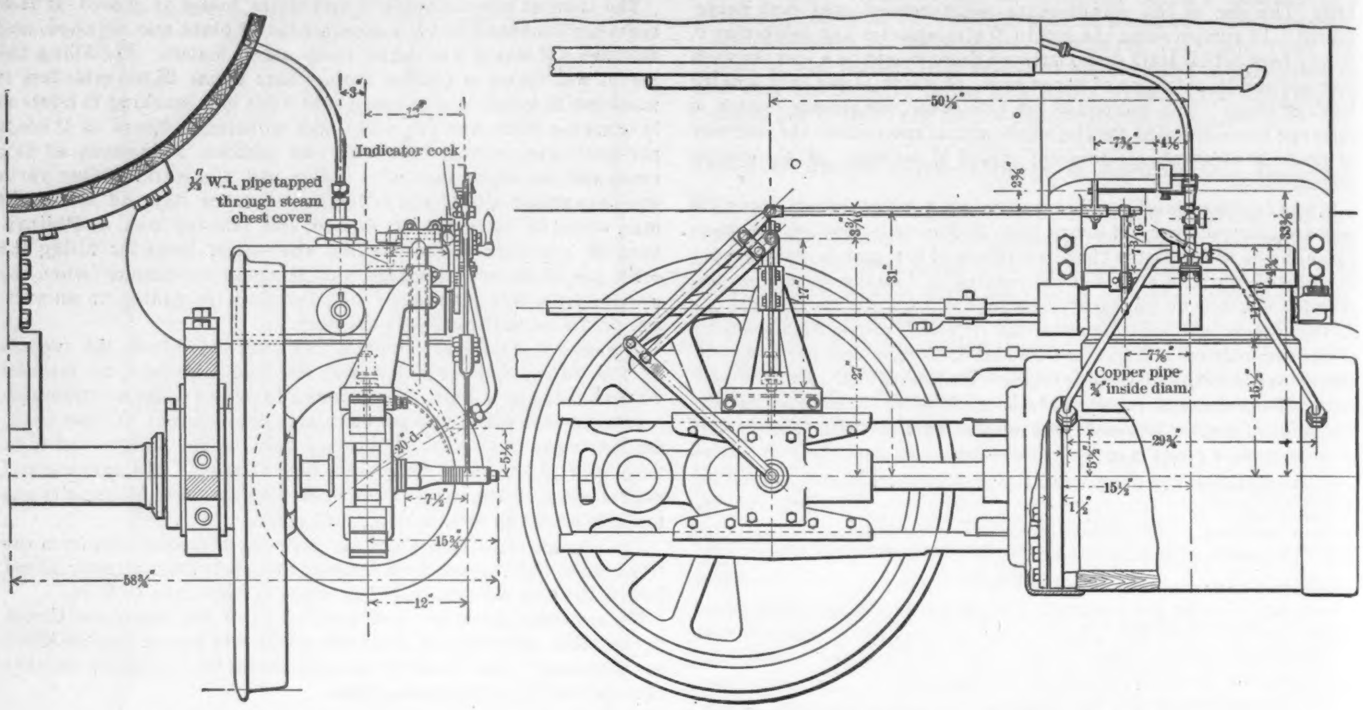


Fig. 1.—General Arrangement of Indicator Rig Applied to a Class R Locomotive.—Pennsylvania Railroad.

hours, then, by line 7, column 4, of the above table, 3,930 cubic feet of city gas must be burned in the Gordon-Mitchell lamps, affording about 29 candle power at 45 degrees, in order to obtain the same total amount of illumination. The cost of obtaining this illumination from the Pintsch lamps would be $5.09 per M; and from the Gordon-Mitchell lamps, $2.883 × 3.93 = $11.33 per M.

In other words, the Pintsch gas might be sold at $11.33 and be as cheap per unit of illumination as the city gas at its cost of $2.883 per thousand stored on the cars. In view of the large difference in candle power of the two lamps, however, equal illumination could not be afforded by them in a car, unless there were nine Gordon-Mitchell lamps to about five Pintsch lamps. Under this arrangement the relative cost of the equal illumination would not be practically altered from the above figures. Such a difference in the number of lamps is, of course, impracticable, so that a use of the Pintsch Argand lamps with Pintsch gas must be accompanied with greater illumination in the car than is obtained from an equal number of Gordon-Mitchell lamps at the service rates of consumption for each which was used in the experiments.

If we do not attempt to represent the difference of the light in the cost of the gas, the comparative cost of the two systems may be represented by the cost per car hour.

This cost, using five Pintsch Argand lamps with Pintsch gas, affording about 54 candle power at 45 degrees, at $5.09 per M, is 8.7c. per car hour.

The similar cost for five Gordon-Mitchell lamps, affording about 29 candle power at 45 degrees, with gas at $2.883 per M, is 11.0c. per car hour.

Therefore, the use of the Pintsch Argand system costs, for gas, about 20% less per car hour than the Gordon-Mitchell system, and affords about 70% more illumination below the horizontal; the candle power at 45 degrees representing about the average intensity of the light over its lower hemisphere of action. The equivalent annual saving by using the two lamps, therefore, neglecting the fact that the Pintsch lamp affords this extra amount of illumination, is as follows:

The average consumption of city gas would be 6,199,525 cubic feet per annum, costing $17,873. The equivalent amount of Pintsch gas would be 2,761,629 cubic feet per annum, costing $14,158. There would, therefore, be an annual saving of $3,715 per annum by the use of the Pintsch Argand system, as compared to the Gordon-Mitchell system, with an illumination proportional to about 29 candle power from the latter system as compared with an illumination proportional to 34 candle power from the Pintsch system.

II. Comparing the Gordon-Mitchell lamp using city gas with the Pintsch four-flat-flame lamp consuming 3.31 cubic feet per hour, affording 35.4 candle power at 45 degrees, the annual costs are as follows:

The total city gas consumed per annum would be 6,199,525 cubic feet, costing $17,873 as before. The total Pintsch gas consumed per annum would be 2,700,056 cubic feet, which would cost $13,743. The use of the Pintsch four-flat-flame lamp would, therefore, save $4,130 per annum over the use of the Gordon-Mitchell lamp with city gas, or the cost of the Gordon-Mitchell gas equals that of the Pintsch gas bought at $6.62 per thousand, and the Gordon-Mitchell lamps afford 20 per cent. less illumination in the most useful direction in the car. If the gas consumption of the four-flat-flame lamp was restricted so that its candle power should be practically the same at 45 degrees as that of the Gordon-Mitchell lamp, the annual saving would be $6,370, or, in other words, the cost of the city gas in Gordon-Mitchell lamps is equivalent to Pintsch gas at $7.90 per thousand.

A Substantial Indicator Rigging for Locomotives.

The more frequent use of the indicator on locomotives has resulted in more carefully designed and better indicator rigs. When indicating locomotives was a novelty in which the master mechanic or chief draftsman indulged about once a year, the cheapest rig that would hold together for that particular time was good enough; now on large railroad systems a substantial rig is desired, and one that is adjustable to many classes of engines. For this reason we think our readers will be interested in the latest rig used on the Pennsylvania Railroad and shown in the accompanying illustrations.

Fig. 1 shows the general arrangement and the manner of applying it to a "Class R" consolidation locomotive. Figs. 2 and 3 give some of the important details. The indicator drum is driven by means of a parallel motion attached to the cross-head pin and supported on an adjustable standard on the top guide. To attach this standard the guide oil cup is removed and an oil stud inserted which bolts the standard down and into the top of which the oil cup is placed. The standard has flanges extending down each side of the guide and is further secured by two pointed set screws in the front flange. The face of the guide has conical recesses to receive the points of the screws. In the upper end of the standard is clamped a vertical cast iron column 2 inches in diameter which is adjustable in height and prevented from turning by a key. The upper end of this column carries a horizontal shaft 1¼ inches in diameter which can be firmly clamped and is adjustable laterally. At its outer end it has a journal 1 inch by 2 for the upper end of one of the long links of the parallel motion.

The various parts of this parallel motion, except the pins and bushings, are shown in detail in Fig. 2. They are all wrought iron cast hardened, and the holes *A*, *B*, *C*, *D* and *E* are provided with bushings. These are a driving fit in the two upper links in Fig. 2, and a working fit in the holes correspondingly lettered in the other links. The bushings are a shade longer than the total width of the links through which they pass, so that the ½-inch bolts inserted through them hold the parts together without binding. The attachment to the crosshead is effected by removing the nuts on the crosshead pin, and in their place putting on first a hexagonal check-nut ½ inch thick and then screwing on the extension piece shown in Fig. 2. This has a 3-inch by 1-inch journal, which can be adjusted laterally 2⅝ inches by means of the leather washers shown.

The indicator three-way cock is firmly bolted to a bracket on

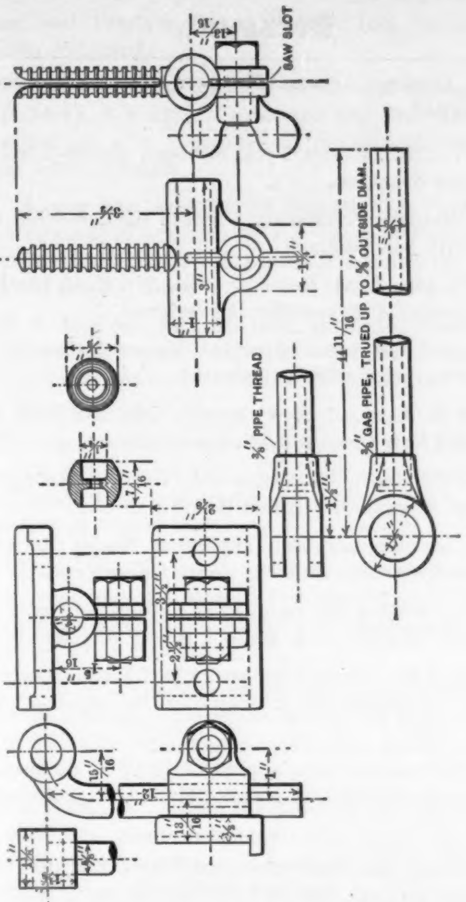


Fig. 3.

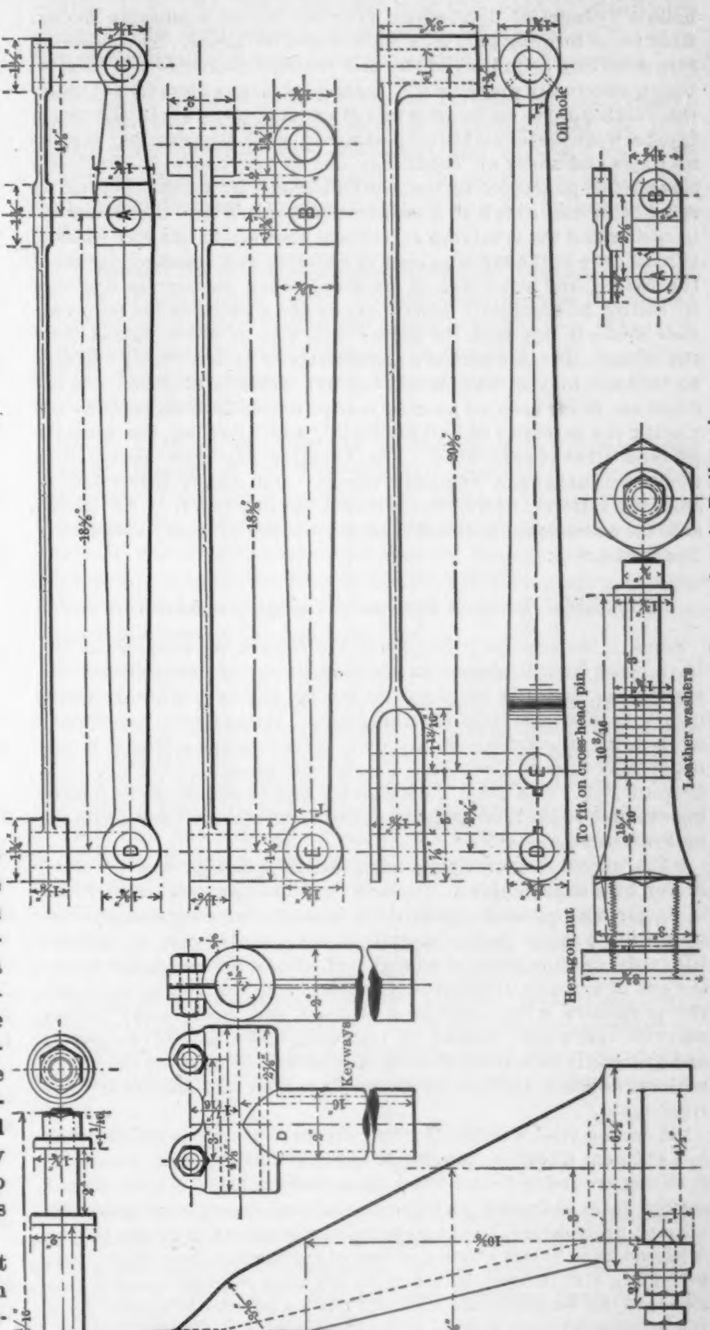


Fig. 2.—Details of Indicator Rig for Class R and Other Locomotives.—Pennsylvania Railroad.

the outside face of the steam chest casing. It is placed as low down as convenience of operation will permit, and being outside of the casing, the pipes to it are more direct and shorter than usual. The cock is piped to the steam chest also. The connection from the parallel motion to the indicator arm consists of a long piece of ⅜-inch iron pipe, with a jaw at its rear end and supported at the front end by an adjustable standard attached to the face of the steam-chest casing. Clamped on to this pipe is an upright pin that is split for the cord and is grooved on the outside to keep the small brass button on the end of the cord from slipping. To connect the cord it is only necessary to pull it out and drop it through the slit in the pin. Disconnecting it is equally easy. This neat arrangement will be appreciated by those who have experienced the difficulties of taking cards at high speeds The details are shown in Fig. 3.

From our description and the illustrations it will be seen that this rig is not only convenient and durable, but it is adjustable in every direction and can be attached to locomotives varying considerably in dimensions. The motion to the drum is perfect, the cord is short and easily connected, and the steam pipes are short and direct. Altogether it is excellent. Mr. A. W. Gibbs, engineer of tests, states that some of the ideas were obtained from the rig used by Professor Goss on the locomotive at Purdue University, but this rig had to be adapted for road service and the features pertaining to the adjustment to various engines and the attachment for the cord are new.

A New Water-Tight Bulkhead Door for Steamships.

In connection with the construction of battleships, as well as of mercantile vessels, there has always been room for improvement in the matter of bulkhead doors. So important a point is it, in fact, that some time ago the British Admiralty appointed a Commission to consider the subject, with the object of adopting some plan whereby the risks run through the water-tight doors being left open would be minimized. The terrible disaster to the British battleship *Victoria*—which might have been averted had the bulkhead doors been closed—has only to be remembered to show the great necessity for adopting some method of preventing occurrences of the kind. It would seem that now the difficulty has been solved, for Mr. Wm.

Kirkaldy, of Glasgow, has invented a bulkhead water-tight door which it is absolutely impossible to leave open. The feature of Mr. Kirkaldy's patent door is its wonderful simplicity. It consists of a hollow cylindrical door, which revolves within a suitable casing, fixed to, or forming part of, a water-tight bulkhead. By combining this revolving cylindrical door and casing a double-door is formed, which effectually prevents the ingress of fire, water, etc., through the bulkhead, yet on being revolved by hand allows free thoroughfare between water-tight compartments, with the certainty that at all times and under all conditions *one of the doors is absolutely closed*, thus guaranteeing that the bulkhead is intact and thoroughly reliable in the event of a sudden disaster. When the doorways in casing and the revolving cylindrical door are in line free passage through the bulkhead is gained by entering and standing inside of the casing and revolving it by hand, when the ingress doorway in casing is absolutely closed before the opening in the revolving door comes in line with the second doorway to allow egress from the casing. In the event of a collision there is absolutely nothing to be done in the way of closing the water-tight doors. As the doors are never open no gearing is required to close them, thus obviating the necessity of bulkhead drill, and allowing the crew to perform other urgent work. The invention has been shown to a number of naval and engineer experts and others interested in shipping matters, who have expressed their approval of its merits and the exceptional features of safety which the door possesses.—*The Steamship.*

Successful Trial of Professor Langley's Aerodrome.

Some of the best contributions to the science of aerial navigation have come from Professor Langley, Secretary of the Smithsonian Institution, and it is well known that he has been making experiments in this direction for a long time. Recently he has been at work upon a machine of his own invention and a trial of it was made May 6, near Occouvan, Va., in the presence of Prof. Alex. Graham Bell. The New York *Sun* of May 14 publishes the following account of the trial as given out by Professor Bell and endorsed by Professor Langley:

"The aerodrome, or 'flying machine,' in question was of steel, driven by a steam engine. It resembled an enormous bird, soaring in the air with extreme regularity in large curves, sweeping steadily upward in a spiral path, the spirals with a diameter of perhaps 100 yards, until it reached a height of about 100 feet in the air, at the end of a course of about half a mile, when the steam gave out, the propellers which moved it stopped, and then, to my further surprise, the whole, instead of tumbling down, settled as slowly and gracefully as it is possible for any bird to do, touched the water without damage, and was immediately picked out and ready to be tried again.

"A second trial was like the first except that the machine went in a different direction, moving in one continuous gentle ascent as it swung around in circles like a great soaring bird. At one time it seemed to be in danger, as its course carried it over a neighboring wooded promontory, but apprehension was immediately allayed, as it passed 25 or 30 feet above the tops of the highest trees there, and, ascending still further, its steam finally gave out again, and it settled into the waters of the river not quite a quarter of a mile from the point at which it arose. No one could have witnessed these experiments without being convinced that the practicability of mechanical flight had been demonstrated."

Professor Langley also made public a supplemental statement, giving some important data regarding experiments. He said: "The aerodrome or flying machine has no gas to lift it, as in the case of a balloon, but, on the contrary, it is about one thousand times heavier, bulk for bulk, than the air on which it is made to run, and which sustains it somewhat in the way in which thin ice supports a swift skater. The power is derived from a steam engine, through the means of propellers, but, owing to the scale on which the actual aerodrome is built, there has been no condensing apparatus to use the water over and over. Enough can be carried for only a very brief flight, a difficulty which does not belong to larger machines than the present example, in which the supporting surfaces are but about fourteen feet from tip to tip. The distance flown each time was about one-half mile. The rate of speed depends (as in the case of any vehicle on land) on whether it is going on a level or up hill. In the case of this last trial of May 6 the machine was ascending, that is to say it was going up hill all the time, and went through a distance of one-half mile or more in one and one-half minutes, or at the rate of a little more than twenty miles an hour."

Personal.

Mr. A. S. Dunham, General Manager of the Ohio Southern road, has resigned.

Mr. H. A. V. Post, of New York, has been chosen President of the Chattanooga Southern.

Mr. H. W. Matters, Purchasing Agent of the Louisville, Evansville & St. Louis, has resigned.

Mr. E. P. Huston, Joint Receiver with Mr. E. O. Hopkins, of the Peoria, Decatur & Evansville, has resigned.

W. A. Meagher has been appointed Master Mechanic of the Gulf & Interstate, with office at Galveston, Tex.

Mr. Charles E. Levy, of New Orleans, La., has been chosen President of the New Orleans & Western Railroad.

Mr. O. Emerson Smith, of Portsmouth, Va., has been appointed Receiver of the Norfolk & Virginia Beach Railroad.

Mr. Walter Layman has been appointed Master Mechanic of the Ohio River Railroad, vice A. L. Courtrite resignad.

Mr. Aldace F. Walker has resigned as Receiver of the St. Louis & San Francisco, and Mr. J. J. McCook is now sole Receiver.

Mr. A. J. Beltz has resigned the position of Master Mechanic of the Delaware, Susquehanna & Schuylkill Railroad at Drifton, Pa.

Mr. Joseph Dickson has been appointed Receiver of the Litchfield, Carrollton & Western, in place of Mr. C. H. Bosworth, resigned.

Mr. F. E. House has been appointed Chief Engineer of the Butler & Pittsburgh road, the new line to be constructed by Carnegie interests.

Mr. F. W. Huidekoper, of New York, has been elected President of the Chicago, Peoria & St. Louis road, in place of Mr. Henry W. Putnam, Jr.

Mr. H. H. Swift has been appointed General Car Foreman of the Cincinnati, Hamilton & Dayton Railroad, with headquarters at Lima, O.

Mr. Charles H. Grundy has been appointed General Manager of the Marshfield & Southeastern, with office at Marshfield, Wis., vice A. A. Hopkins.

Mr. J. H. Hill has been appointed General Manager of the Galveston, Houston & Henderson, taking effect May 15, with headquarters at Galveston, Tex.

J. H. Reed has resigned the Vice-Presidency of the Pittsburgh & Lake Erie Railroad Company, to identify himself with the Carnegie railroad interests.

Mr. E. D. Bronner, Master Car Builder of the Michigan Central, has been appointed Assistant Superintendent of Motive Power of that road, with headquarters at Detroit, Mich.

Mr. George T. Jarvis, who has been recently appointed Receiver of the Louisville, Evansville & St. Louis Consolidated road, will also act as General Manager of the company.

Mr. M. F. Bonzano, late General Superintendent of the South Jersey, has accepted the position of General Manager of the Chattanooga Southern, with headquarters at Chattanooga, Tenn.

Mr. W. Cockfield has resigned the position of Locomotive and Car Superintendent of the Interoceanic Railway and has been appointed Master Mechanic of the Mexican Central, at San Luis.

Mr. C. H. Doebler, formerly Master Mechanic of the Big Four at Wabash, Ind., has been appointed Master Mechanic of the Eastern division of the Wabash Railroad, with headquarters at Fort Wayne, Ind.

Mr. Frank J. Zerbee has been appointed Master Mechanic of the Michigan division of the Cleveland, Cincinnati, Chicago &

St. Louis, with headquarters at Wabash, Ind., to succeed Mr. C. H. Doebler, resigned.

Mr. W. J. Karner has resigned as General Manager of the St. Louis, Belleville & Southern road and the Crown Coal and Tow Line, which are now controlled by the Illinois Central, and the office has been abolished.

Mr. J. Layng has been elected Second Vice-President of the West Shore road, in addition to the office of General Manager, which he has held for several years. He is also the second Vice-President of the Big Four.

Mr. W. R. McKeen, Jr., has been appointed General Foreman of the locomotive department of the Vandalia line, with headquarters at Terre Haute. He retains his position of General Foreman of the car department.

Mr. Thomas Trezise, Master Mechanic of the Philadelphia division of the Baltimore & Ohio, has been transferred to the Pittsburgh division, with headquarters at Pittsburgh. Mr. E. T. White succeeds him at Philadelphia.

Mr. George W. N. Reed, formerly Treasurer of the Pratt & Whitney Company, of Chicago, has been elected Vice-President and General Manager of the company. He has been succeeded as Treasurer by Mr. J. C. Stirling.

Mr. C. J. Clifford has been appointed Superintendent of Motive Power of the Chicago, Lake Shore & Eastern Railway Company. Mr. E. B. Smith is appointed Master Car Builder, reporting to Superintendent of Motive Power.

Mr. I. N. Kalbaugh, Master Mechanic of the Baltimore & Ohio at Glenwood, Pa., has been appointed Division Superintendent of Motive Power of that road, with headquarters at Baltimore, Md., to succeed Mr. A. J. Cromwell, resigned.

Mr. G. W. Dickenson has been appointed General Manager of the Northern Pacific, with headquarters at Tacoma, Wash. Mr. W. L. Darling has been appointed Chief Engineer, with headquarters at St. Paul, vice E. H. McHenry.

Mr. W. A. Bell, foreman of the shops of the Cleveland, Cincinnati, Chicago & St. Louis, at Dillon street, Indianapolis, Ind., has been appointed Master Mechanic of the Louisville division of that road, with headquarters at Louisville, Ky.

Mr. T. J. Hennessy, formerly Traveling Engineer of the Michigan Central, has been appointed Division Master Mechanic of that road, with headquarters at Jackson, Mich. Mr. Peter Miller, Acting Master Mechanic, has been made Master Mechanic.

Mr. E. S. Washburn, Vice-President of the Kansas City, Fort Scott & Memphis, was on May 12 chosen President of the Kansas City Belt Railway and the Kansas City Union Depot Company, positions made vacant by the decease of Mr. George H. Nettleton.

Mr. H. G. Frazer, Auditor and Purchasing Agent, and Mr. E. Fairfax, Treasurer, of the Knoxville, Cumberland Gap & Louisville, have retired from their respective positions on account of the sale of the road to the Southern Railway, and the offices have been abolished.

Mr. E. V. Sedgwick, formerly Master Mechanic of the Mexican Central, and for a short time Locomotive and Car Superintendent of the Interoceanic Railway, has been appointed Superintendent of Motive Power and Superintendent of Transportation of the latter road.

Mr. William H. Schoen, of the Schoen Manufacturing Company, and a brother of the President of that company, died on May 18, aged 54 years. Mr. Schoen became associated with the company at the time of its organization and remained with it up to his death.

Mr. P. M. Hammett has been appointed Division Master Mechanic of the Boston & Maine, at Boston, vice Mr. A. B. Barrett. Mr. D. A. Smith has been appointed Master Mechanic of the Eastern, Western and Northern divisions, with headquarters at Somerville, Mass.

Mr. Bernard Vogle has been appointed Mechanical Engineer of the Delaware & Hudson Canal Company, with office at Green Island, N. Y. Mr. Vogle has been with this road for nearly ten years as Chief Draftsman, and has practically occupied the position of Mechanical Engineer for the past three or four years.

Owing to his protracted illness, the Directors of the Pennsylvania Railroad have granted General Superintendent Mr. F. L. Sheppard an indefinite leave of absence, and appointed Mr. J. M. Wallis, at present Superintendent of Motive Power on the division, Acting General Superintendent during Mr. Sheppard's disability.

Mr. Adolph Bucze has been appointed General Purchasing Agent for the Grand Trunk road. At one time he was Purchasing Agent of the Missouri Pacific, but recently he has been in the railroad supply business at St. Louis. The Grand Trunk heretofore has not had a Purchasing Agent, the department being in charge of the General Storekeeper.

Mr. J. T. Odell has resigned as Second Vice-President and General Manager of the New England Railroad to accept the presidency of the Butler & Pittsburgh, projected from Butler to Pittsburgh, Pa. His headquarters will be at the latter place. Mr. Odell was Vice-President and General Manager of the New York & New England and its successor, the New England, since 1893, previous to which date he was for four and one-half years General Manager of the Baltimore & Ohio.

Mr. William S. Sloan, Second Vice-President of the Delaware, Lackawanna & Western Railroad, died May 12, of paralysis, at South Wilton, Conn., where he has been undergoing treatment for nervous prostration for some time. Mr. Sloan was the son of the President of the Delaware, Lackawanna & Western. He was born in Brooklyn in 1859, and was graduated from Columbia in 1882. He entered the service of the Delaware, Lackawanna & Western Railroad and rose to the position of Second Vice-President. He was Vice-President of the Fort Wayne & Jackson Railroad, a director in the Bank of the State of New York, a member of the Executive Committee of the American Tract Society, treasurer of the South Dutch Reformed Church and secretary of the Columbia College Alumni Association. Mr. Sloan was of a quiet and studious nature and greatly interested in the work of the Y. M. C. A., having been one of the heads of that association in this country. Mrs. Sloan and five children survive him.

Col. Frank K. Hain.

No event which has occurred for a long time has caused so much pain and produced such a shock to those who knew him, as the tragic death of Colonel Hain, which occurred at Clifton Springs, N. Y., on May 9. He had been suffering from nervous prostration for several months and had gone to a sanitarium for rest and medical treatment. On the afternoon of the 9th he left the institution and walked down to view the railroad station. Soon after he was discovered under a moving train, some of the cars of which had passed over him. When taken out he was still living, but died before medical aid reached him. The accident was not seen by any one and it is not known how it occurred. For the following particulars relating to his life and career we are indebted to the New York *Herald*:

"Colonel Frank K. Hain was born in Berks County, Pennsylvania, about fifty years ago, and commenced his railway career in early youth as an apprentice in the machine shop of the Philadelphia & Reading Railroad. Here, by constant attention and unwearied application, he early in life fitted himself for the eminent position he afterward occupied among American engineers.

"At the end of his apprenticeship he entered the United States Navy at the age of twenty-one as an engineer, serving for two years, and participating in some of the most memorable naval engagements of the late war. Among these were the capture of Forts Jackson and St. Philip and the city of New Orleans by the fleet under Admiral Farragut.

"Withdrawing from the navy he entered into still more active service in the army, in which he won reputation as a brave and

gallant officer. At the close of the war he obtained employment as a draughtsman with the Delaware, Lackawanna & Western Railroad Company at Scranton, after which he entered the service of the Pennsylvania Railroad Company at Altoona. Here his abilities as an executive officer were soon acknowledged, and he was promoted to be Superintendent of Motive Power for the Philadelphia & Erie Division of the road.

"From this position he withdrew to accept charge of the designing department of the great Baldwin Locomotive Works, of Philadelphia. In 1871 he visited Russia in the interest of the firm and spent some 15 months in introducing and putting into operation 20 anthracite coal-burning locomotives which he had previously designed.

"Colonel Hain was offered the position of Superintendent of Motive Power on the Erie Railroad two years later, which he accepted. He afterward became General Superintendent of the Keokuk & DesMoines Railroad, maintaining his position after the road became merged into the Chicago, Rock Island & Pacific system

"Colonel Hain was best known to the New York public through his connection with the elevated railroads of this city. When the New York and the Metropolitan Elevated Railroad lines were leased to the Manhattan Company it was found that a competent man was needed as General Manager or Superintendent. Russell Sage and the late Jay Gould recommended to the Board of Directors that Colonel Hain be appointed to the position."

It is not easy, in a brief summary like this, to do justice to the life and character of a man like Colonel Hain, as he was generally known among his friends. He was a man of indefatigable industry and energy, and perhaps in the position which he occupied his greatest deficiency was his inability to lay responsibilities on other shoulders, instead of assuming them himself. The remarkable record of the road which he managed for so many years, which has carried many millions of passengers during that period, with almost complete immunity from accident, excepting through the fault or carelessness of those who were injured, shows how ably and conscientiously every department was supervised. By day and by nght, in sunshine, fog and storm, the responsibility for the operation of this road was borne by Colonel Hain, with little relaxation and no complete relief. More than a year ago there were signs of physical failure, but against the advice of friends, he continued in the harness. A few months ago work was no longer possible, and he received leave of absence and went, it was reported, South, for rest and recuperation. The few weeks before his death were spent at Clifton Springs.

To those who were not intimately acquainted with him he was reserved and reticent, but, once in his confidence, he was a genial companion and warm-hearted friend. He was deeply interested in his occupation, and faithful and loyal to those who employed him—much more so than they were and are to the public, which they ought to serve better than they do. In his domestic relations Colonel Hain's life was very happy. His wife was a true helpmeet to him, and guarded him in every way possible from the cares and annoyances incident to his occupation. To those who were privileged to enjoy the friendly and confidential talks with him in his own household they will always be a memory to be cherished as long as life lasts. To some who survive him his life and death may serve as a warning, by others it will be tenderly remembered, and to all he may be an example of faithfulness and loyalty to duty.

The Passenger Department of the New York Central road has just issued a new summer folder, entitled "America's Great Resorts." It is number three of the "Four Track Series" of folders, and is replete with information of a practical kind. All the leading resorts, both east and west, are mentioned in it, and the rates and time from New York and from Niagara Falls approximately given. This information will be found valuable to those who contemplate a summer trip, in arranging the details of their journey. The folder is handsomely illustrated and contains a large and accurate map. A copy of the folder can be obtained by sending four cents in stamps to Mr. Geo. H. Daniels, General Passenger Agent of the road, New York City.

The *Scientific American* is going to celebrate its fiftieth anniversary on July 25, by issuing a special number, one of the features of which will be a prize essay on the "Progress of Invention During the Past Fifty Years." A premium of $250 will be paid for the best essay of not more than 2,500 words. The five next best essays will be published later and paid for at regular rates.

Equipment Notes.

The specifications are out for 200 cars for the Chicago Great Western.

The Florida East Coast Railway is in the market for 100 ventilated box cars and 100 flat cars.

The Cold Blast Transportation Company., Kansas City, is in the market for 100 refrigerator cars.

The Georgia & Alabama road is in the market for six locomotives, three passenger and three freight.

H. K. Porter & Company have received an order for a locomotive for the Rockhill Stone Storage Company.

The Parkersburg shops of the Ohio River road have just turned out a private car for Vice-President G. A. Burt.

The Lehigh Valley has ordered 25 freight and 5 passenger locomotives from the Baldwin Locomotive Works.

The Texas & Pacific has contracted with the Mount Vernon Car Manufacturing Company for 300 freight cars.

The Pennsylvania Railroad has received two large wrecking cars from the Industrial Works, of Bay City, Mich.

The Erie road is building an 80,000-lb. coal car which is to be fitted with automatic devices of the Dumping Car Improvement Company.

The Southern Railway has contracted for six freight engines with the Brooks Locomotive Works and four with the Pittsburgh Locomotive Works.

The Pullman Palace Car Company has received an order for 20 passenger cars for the Brooklyn Bridge at $3,200 each. The cars are to be provided with electric motors.

The Great Northern is receiving 400 ballast cars from the Roger Ballast Car Company. The cars are combination ballast, coal and ore cars with a capacity of 20 cubic yards or 30 tons.

The Munising Railroad has placed orders through J. T. Gardner, Chicago, for 200 flat cars, 100 going to the Barney & Smith Car Company and the other 100 to Haskell & Barker Car Company.

The Chicago, Milwaukee & St. Paul is providing a convenient means of transporting bicycles without damage by putting in its baggage cars overhead rods carrying rubber-covered hooks on which they can be hung.

The Baltimore & Ohio has contracted with the Safety Car Heating and Lighting Company for the equipment of 200 passenger cars with the Pintsch light. Pintsch gas plants will be erected at Baltimore, Washington and Pittsburgh.

According to the statement of the receivers to the court, the new cars for the Philadelphia & Reading recently ordered were contracted for at the rate of $575.83 for each coal car; box cars, $607.83; gondola cars, $475.82; refrigerator cars, $892.83.

A law has been passed requiring the Manhattan Elevated to light its passenger cars by gas or electricity. It requires 40 per cent. of the company's cars to be so equipped within one year, 40 per cent. more within two years and all of the equipment within three years.

The ten switch engines built for the Chicago & Northwestern Railway by the Schenectady Locomotive Works are equipped with Latrobe open hearth steel tires, Midvale steel connecting rods, Nathan lubricators and injectors, five with American and five with Richardson balance valve, Ashcroft gages and Ashton pop safety valve. The boilers are made of carbon steel and covered with the "sall mountain" asbestos covering, mentioned in our May issue, of which Bruner, Sprague & Company, of Chicago, are the agents.

Contracts for the 5,000 new freight cars for the Baltimore & Ohio Railroad were given out early in the month as follows: South Baltimore Car Works, 1,000; Pullman Palace Car Company,

1,000; Missouri Car and Foundry Company, 900; Michigan-Peninsula Car Company, 800; Barney & Smith Car Company, 800, and Mount Vernon Car Company, 500. Of this order 1,800 are single-hopper cars, 1,800 box cars, 1,000 coke cars and 400 double-hopper coal cars. It is stated that the Buckeye coupler and the Schoen pressed steel bolster will be used on all of these cars, the Chicago roof on the box cars, and that the order for springs has been divided among the Pickering Spring Company, the A. French Spring Company and the Chas. Scott Spring Company. The Davis box lid, manufactured by the Davis Pressed Steel Company of Wilmington, Del., will be used on a large part of this equipment.

New Locomotives.

The New York, New Haven & Hartford Railroad Company has recently placed an order with the Schenectady Locomotive Works for 20 heavy passenger locomotives. They are to be of the American type with 20 by 24-inch cylinders and 73-inch driving wheels with steel centers. The engines will weigh about 134,000 pounds. The boilers are to be 62 inches diameter in the smallest ring, with 312 2-inch tubes 12 feet long. The firebox will be of the "toboggan" type placed on top of the frames and will be 9 feet long and 41 inches wide. The boilers are to have an extended wagon top with radial stays, the dome being on the extension of the wagon top. The maximum travel of valves is to be 6 inches. The guides are to be of the crocodile form, that is, one bar above and the other below the cross-head. The boilers are made very heavy, with butt longitudinal joints, sextuple rivetted. The specifications were prepared by Mr. John Henney, Jr., Superintendent of Motive Power of the line. The engines will be the most powerful of their class which have thus far been built.

The Schenectady Company are also completing five Mogul freight engines for the Maine Central road. These will have 20 by 26-inch cylinders and 63-inch wheels.

Mr. Harvey Middleton, the new Superintendent of Machinery of the Baltimore & Ohio Railroad, has prepared specifications for some new heavy ten-wheeled passenger engines for that line. They are to have 21 by 26-inch cylinders and 78-inch driving wheels, and will weigh about 140,000 pounds. Owing to the short curves on this line the total wheel base of these engines will be only 24 feet 6 inches and the driving wheel base 13 feet 8 inches. The trailing driving axle is under the middle of the firebox, and the other wheels are placed as near together as their diameters will permit. The firebox is also of the "toboggan" type, placed on top the frames and with an extended wagon top and radial stays.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3¾ inches by 6⅛ inches.
Pamphlets and trade catalogues	3⅛ inches by 6 inches. 6 inches by 9 inches. 9 inches by 12 inches.
Specifications and letter-paper	8¼ inches by 10¾ inches.

ILLUSTRATED PRICE LIST OF ARCHITECTS, ENGINEERS AND DRAUGHTSMEN'S SUPPLIES. *F. Weber & Co., Philadelphia.* 259 pages, 6 by 9 inches. (Standard size.)

This is an elaborate catalogue, which gives a great deal of detailed information about the materials and instruments used by architects, engineers and draughtsmen, and sold by this firm, but it does not seem to call for special comment.

CATALOGUE OF PEDRICK & AYER COMPANY, *Manufacturers of Special Railroad Machine Tools.* Philadelphia. 105 pages. 6 by 9 inches. (Standard size.)

The tools manufactured by this company include Richard's patent open-side planer, which is made in a number of sizes. Full descriptions are given of this machine and also illustrations showing the kind of work which can be done on them and the method of doing it.

The list of tools of this company also includes shapers, plate-scarfing or planing machine, specially constructed for scarfing steel ship plates, nutting machines, five forms and sizes of which and various attachments for them are described and illustrated. These attachments include universal index-heads, vertical index-heads, vertical or angular attachments, vises for holding work, vise chucks, circular attachments, etc. Following these are a series of illustrations showing how work can be done on these machines with direction for doing it. Among the other tools which are made by this company, and are illustrated in this publication, are universal grinding machines, portable valve-seat votary planing machine, chucks for holding valves while they are being planed, portable crank-pin and wrist-pin turning machines, horizontal boring and drilling machines, cylinder boring and facing machines, portable cylinder boring machine, and various tools, chucks and other devices, to be applied to the machines which the company makes.

Another apparatus is intended for heating, setting and removing tires. "It consists of an oil tank and a furnace, the latter having over the fire grate four retorts; the first three of them for making gas, and the fourth for heating the compressed air. The three gas cylinders are connected together so that the gas in its passage from the first retort, where the oil is admitted, becomes very hot. The fourth cylinder, being in the hottest place, heats the air to about the same temperature." The oil is thus converted into gas and is burned in contact with the tires, being mixed with air in the burners.

Other machines which the company makes are Otto's patent flue cleaner, a jointer for facing brasses of connecting rods, a locomotive lath motion model, etc.

A new department, which has been added to the establishment, is that for making air compressors, pneumatic hoists and appliances used in connection with this class of machinery; the extensive use of which has made it an important branch of the business. Special attention is now given to this department and various new appliances have been brought out.

The catalogue is illustrated by excellent wood cuts, is well printed and has a good index, all of which can be commended.

The Jungfrau Railway.

Competitive plans are desired by the Bureau der Jungfraubahn, Bahnhofstrasse 10, Zürich, for the proposed railway to the summit of the Jungfrau. The sum set apart for the purpose of making awards to the successful competitors is about $6,000. The prizes in question are offered for the best solution of three different groups of problems. The first of these relates to the construction of the line, and plans are desired showing the tunnel profile; the lining, if any, the kind of permanent way and superstructures proposed ; the racks, points and switches. The question of electrical power transmission from the falls on the Lutschine River is also included in the first group, together with the designs for the cars, stations, club buildings and elevator from the last station to the mountain summit. The lift of the elevator is fixed at 328 feet, and the shaft is to be 26 feet in diameter, and to be provided with stairways. In the second group of problems proposals are required for methods of executing the work, the driving of the tunnels, removal of spoil, and of precautions for the safety of the men. The third group is concerned with the working of the line, and competitors should deal with the question of maintenance of the way, the electric lighting of the tunnel, cars and stations, and with heating of the two latter by the same agent. Finally, the security of the passengers and staff should also be considered in this connection. Such plans as are sent in will be considered by experts, on whose recommendations the premiums will be awarded. Successful competitors will have no further claim on the committee, as the prize is considered to be considered as payment in full for the use of the premium designs. Unsuccessful designs will be restored to their originators and will remain their private property.

The maximum gradient of the proposed line is fixed at 1 in 4, and the minimum radius of curvature at 328 feet. The maximum width of the cars must not exceed 8.2 feet, and the greatest height

9.84 feet. The speed has been fixed at from 4.3 to 6.2 miles per hour. The water power available is 5,000 horse power effective. The falls are situated at about five miles from the proposed starting point of the line, which will be about 1.5 miles from the tunnel portal. The total length of tunnel will be about 6.2 miles. The latest date for sending in proposals is August 1 next.—*Iron Age.*

The Steam Boiler Plant of the National Electrical Exposition.

The Improved Root Water Tube Boiler, manufactured by the Abendroth & Root Manufacturing Company, of New York, was selected to furnish all the steam used at the National Electrical Exposition, now open in New York, there being two equal units forming one battery of 500 horse power of boilers. The well-known anthracite automatic stoker, manufactured by the Wilkinson Manufacturing Company, of Bridgeport (Montgomery County), Pa., was selected to handle the coal supplied to the fire.

The coal, after being dumped at some distance from the boilers, in the rear, is taken by the C. W. Hunt coal conveyor and carried along the side and a little past the front of the boilers where it is elevated to a point near the ceiling from whence it is delivered through tubes to the hoppers of the Wilkinson Stokers, and, of course, from that point it is fed uniformly down the inclined grates, burning on its way and reaching the foot of the grates as ash, and finally it is dumped into the ash pit below.

The Hunt conveyor next takes the ash and carries it back to a dumping place some distance in the rear of the boiler, dumping it there automatically.

The water of New York City being especially well adapted for boiler use, no filters or purifiers were considered necessary. The pump supplying feed water to the boilers is one of the H. R. Worthington Company's make, and is electrically driven by one of Crocker-Wheeler Company's pump motors: The pump is one of the "steeple pattern," and combined with its motor presents a novel and elegant appearance.

Two of the Root feed-water regulating devices, manufactured by the Abendroth & Root Manufacturing Company, of New York, work in connection with the boilers and feed pump, starting the pump automatically when the water level in the boiler falls below its proper level, and again stopping the pump when the water in the boiler tends to rise above its normal working level.

Thus the entire working of the boiler is made automatic, even to the damper regulation, which is effected by the mechanism made by the Locks Damper Regulator Company, of Salem, Mass.

The entire operation of this plant is so safe and simple that it was decided to put it in charge of a woman to show conclusively that if steam-users will put in the best of everything that the market places at their disposal, and if they will equip their plant properly throughout, it will become so simple in its operation that a woman can operate it as well as the most expert fireman.

The valves used in the main steam piping are especially adapted to high-pressure and ordinary rough handling. They are heavy, straight way valves with an outside yoke and screw and are made by the Chapman Valve Manufacturing Company, of Indian Orchard, Mass.

The pressure carried by the boilers is 125 pounds. This pressure is carried along the main steam piping to a point just beyond the first engine and there it is reduced by a reducing valve to 90 pounds, at which pressure it is carried to all the other engines on exhibition.

At the exhibit of the Ashcroft Manufacturing Company two Edson recording gages will be found in operation, one recording the pressure of steam at the boiler and the other gage recording the pressure on the low pressure side of the reduction valve.

The boilers are equipped with steam gages manufactured by the Ashcroft Manufacturing Company, and with nickel seated pop safety valves made by the Consolidated Valve Company, both of New York and Bridgeport, Conn.

The fine smooth black finish of the boilers is produced by the use of Dixon's Graphite Boiler Front Paint made by the Joseph Dixon Crucible Company, of Jersey City, N. J., whose exhibit will be found in the neighborhood of the boilers. The mason work is certainly of exceptionally fine appearance and is most creditable to the mason, Garret S. Wright, of New York.

The exhaust piping from the 11 engines will probably interest many of the visitors to the Exposition as it has been used by so many electric light companies for this purpose. We refer to the spiral riveted pipe made by the Abendroth & Root Manufacturing Company, of New York.

The battery of improved Root boilers use at this exposition is in-exact duplicate to the twelve batteries of boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad in Baltimore, Md.

The engines on exhibition are all direct connected with generators with two exceptions.

The engines will be found arranged in the following order, beginning with engine nearest to boilers:

The Phœnix engine (the only compound engine).
The Ball & Wood engine.
The Straight Line engine.
The Harrisbugh engine.
The Watertown engine.
The Payne engine.
The McEwen engine.
The Weston engine (belted).
The New York Safety engine (belted),
The Case engine.
The Shepard engine.
The Woodbury Engine.

The exhaust from all of these engines is passed through a Goubert feed-water heater and then sent through the spiral riveted exhaust pipe (placed outside the building) to a point above roof.

All the feed water used will pass through this heater, thus supplying the boilers with a bountiful supply of water heated to near 212 degrees.

Part of the steam pipe covering work is Keasbey & Matteson's magnesia sectional covering, while the other is Gilmour's asbestos covering.

Cast-Iron Wheels in Europe.

Of all the European countries Austria is the only one where the use of cast-iron wheels for railroad purposes is not now prohibited by law, and where, consequently, their manufacture has not been entirely killed. Those laws originated at a time when the make-up of such wheels was far from the present state of perfection as manufactured in the United States.

The general use of these wheels in the United States gave to the manufacturers an opportunity of improving their methods, and to furnish better ones, so that the manufacture of cast iron wheels is to-day a large industry in the United States, and it is said there are more cast-iron wheels manufactured in the United States in one day than in all Europe in one year.

That cast-iron wheels are, nevertheless, well liked wherever they are used is proven by the fact that the Austrian Government, during the past year, asked its representative in the United States, Mr. Fr. von Emperger, Consulting Engineer, 71 Broadway, New York, to make an investigation of the American practice. As a result of this investigation the Austrian Govermnent railways placed an order with a prominent car wheel maker for 120 car wheels of the standard size, for the purpose of using them on freight cars with brakes. The lot has been delivered, but cannot be used elsewhere than within the Austrian boundaries. The reason of this limitation is a rule of the German Railway Union Code, which comprises all central Europe, or at least all the States neighboring Austria. This rule prohibits the use of brakes with cast-iron wheels, and the interchange of cars with cast-iron wheels is therefore impossible, except within the Austrian boundaries, where the railway system comprises some 6,000 miles.

If, by these trials, the European officials can be induced to abolish the above-mentioned rule of the German Railway Union Code there would be a bright prospect for the export of cast-iron wheels to Europe, as the necessary experience and skilled labor, as well as the requisite machinery, cannot be had anywhere in Europe. This trade is, of course, limited to Austria for the present, so far as railways are concerned, and to street railway equipment.

The Bushnell Car Seats.

The eight new passenger cars for the Lehigh Valley's new train between New York and Buffalo, known as the "Black Diamond Express," are all equipped with seats made by the Bushnell Manufacturing Company, of Easton, Pa. The two trains for this service are among the finest ever equipped, and these seats were selected for their beauty and excellence from the samples submitted to the company by competing concerns. They are finished with specially designed mahogany arm rests, and are upholstered in mahogany colored frieze plush.

Since Jan. 1 the Bushnell Manufacturing Company has secured many large and important contracts on both street and steam railways, among which may be mentioned seats for 20 sleepers built by

the Wagner Palace Car Company; 20 cars for Detroit Street Railway Company; 10 cars for Akron, Bedford & Cleveland Railway Company; 18 cars for Cleveland, Painesville & Eastern Railway; 20 cars for Milwaukee Street Railway; 8 cars for Lehigh Valley Railroad; 38 cars for Metropolitan Street Railway of Kansas City; 10 cars for Delaware, Lackawanna & Western Railroad; 15 cars for Philadelphia & Reading Railroad, and 30 cars for Broadway Cable Railway, of New York.

The success which these orders indicate is the result of excellence of design in their output, coupled with the high-grade materials employed.

The New York office of the Otis Steel Company has been removed to the Manhattan Life Building, No. 66 Broadway.

Fox Solid Pressed Steel Company have removed their general offices to rooms 1405, 1407 and 1409, in the Fisher Building, 281 Dearborn street, corner of Van Buren street, Chicago.

Mr. James McLaughlin, recently with the Philadelphia Engineering Works, Limited, has been elected Secretary and Treasurer of the Barr Pumping Engine Company, Philadelphia. Mr. W. W. Lindsay is the General Manager of the latter company.

The Diamond Machine Company, of Providence, R. I., are shipping to the Japanese Government a large order for grinding machinery received through their London house. The shipment comprises a large number of articles, including, among others, ten of their large size water-tool grinders.

Carbon Steel Company, manufacturers of acid open-hearth steel, locomotive firebox and boiler plates, and universal plates for bridge and building purposes, announce the removal of their Chicago offices to rooms 1411 and 1413, in the Fisher Building, 281 Dearborn street, corner of Van Buren street.

The Westinghouse Air-Brake Company intend putting a roof over the open space between their foundry and blacksmith shop buildings at Wilmerding. This will give them additional foundry room to the extent of 50 by 500 feet, in which they will erect another system of flask carriers, thereby increasing the output of their foundry from 30 to 40 per cent.

The Continental Iron Works, Brooklyn, N. Y., have supplied four Morison suspension furnaces to the Tuttle Manufacturing and Supply Company, of Anaconda, Mont., three to the International Navigation Company, of New York, for the steamer *Illinois*, and six to Wm. B. Pollock and Company, Youngstown, O. Also several to the Plant Steamship Company, for use on their steamers.

The Franklin Institute, of Philadelphia, after carefully examining into the merits of Cleveland Twist Drill Company's grip sockets, have awarded the firm the Edward Longstreth medal of merit. This action on the part of the Franklin Institute endorses the company's statements, that this grip socket is the best device for holding and driving taper-shank twist drills that has ever been introduced.

The Geometric Drill Company, of New Haven, Conn., has removed to their new factory at 150 Ashman street. The management is in the hands of W. J. Smith, as heretofore. H. E. Adt, who has been connected with John Adt & Son for 15 years, has become associated with the Geometric Drill Company, and will be in charge of the business department. He will also assist in the designing of special machinery.

Judge Dallas, of the United States Circuit Court for the Eastern District of Pennsylvania, filed an opinion on the 6th ult. granting the Ewart Manufacturing Company a preliminary injunction against James H. Mitchell, restraining the latter from the manufacture of an infringement of the plaintiff company's patented chain, which is known as the "Dodge Chain," and which is legally manufactured by the Link-Belt Engineering Company, of Philadelphia, and the Link-Belt Machinery Company, of Chicago.

Mr. E. P. Roberts, Consulting Engineer, and President of the Correspondence School of Technology, Cleveland, O., has been appointed Consulting Engineer for the Port Clinton, O., Electric Light and Power Company. He is also engineer for the Massillon State Insane Asylum, Massillon, O., having charge of the electrical, heating, hydraulic and sanitary work, the latter two departments being taken care of by Mr. E. C. Cooke. Mr. Roberts is also Consulting Engineer for the Columbus State Hospital. All these are new plants on which bids will be called for within the next 30 days.

The U. S. Standard Drawn Steel Company has been incorporated in Ohio, with a capital stock of $50,000, and will manufacture stay bolts and hollow and solid shafting, also weldless tubing of brass, copper, iron and steel, solid cold drawn shapes in steel, and solid and hollow billets. The officers are: President, Samuel A. Sague; Vice-President, L. E. James; Secretary; C. E. Westhafer; Treasurer, C. H. Howland. The works will be located at Cuyahago Falls, O., and the general office in the Western Reserve Building, Cleveland, O. Hydraulic machinery will be used to a large extent in the new plant.

The Erie Railroad Company, after careful investigation, and the consideration of a number of plans, have contracted with the Dodge Coal Storage Company, of Philadelphia, Pa., for a 150,000-ton storage plant at East Buffalo, N. Y. The coal will be stocked in nine divisions or piles, each of about 17,000 tons capacity. The plant will be constructed under the patents of the well-known Dodge system, with the latest improvements, including a complete haulage system for handling the cars. The efficiency of the Dodge system is indicated by the fact that every railroad using it has contracted for a second plant, after more or less extended experience with the first.

Mr. T. F. DeGarmo has been appointed Eastern Representative of the Chicago Pneumatic Tool Company, with office in New York; and William Mack, as Western Representative, with office in Denver, Colo. The company are shipping to Europe three hundred (300) machines of their largest size, and are arranging to open a branch office in London. They have added to their line the Manning Sand-papering Machine, which is meeting with great success, and has proven a great labor saver on coach work; a pneumatic car cleaner for cleaning upholstered seats and carpets in the car and sending the dust through a hose out of the window; and the Manning piston air drill, which is an entirely new machine on the market.

At a meeting of the New York and Brooklyn Bridge trustees, on May 20, the Babcock & Wilcox Boiler Company was awarded a contract for two 400 horse-power boilers for $4,350. The Walker Manufacturing Company, of Cleveland, O., got the contract for two generators of 400 kilowatts, each at $15,849. The Southworth Foundry and Machine Company, of Philadelphia, received the contract for two 600 horse-power engines at $16,400. Twenty passenger cars, 48 feet long, and provided with electric motors, were ordered of the Pullman Palace Car Company, at $3,200 each. The trustees authorized Chief Engineer Martin to advertise for bids for an extension of the power house adequate to receive the additional machinery. This machinery ordered is for the electrical equipment for switching trains at the terminals.

Bids for the machinery and electrical equipment for the new Bascule bridge at N. Halsted street, Chicago, were opened on May 11. The machinery bids were as follows: Vulcan Iron Works, Chicago, $12,956; Chas. Kaestner & Co., $15,845.

The bids for electrical work were as follows: General Electric Company, $7,000; Geo. P. Nichols & Bro., $6,272.50; Vulcan Iron Works Company, $5,379.

The contract for the substructure had previously been let to Wilson & Jackson, Chicago, and for the superstructure to the King Bridge Company, Cleveland. This is to be one the finest equipped bridges in the city, and is to be of the same pattern as the Metropolitan Elevated bridge at Jackson street, which is working so successfully.

In a neat little pamphlet issued by the Standard Paint Company, 2 Liberty street, New York, the method of applying "P. & B. Ruberoid" car roofing is described. This material has as a foundation the best felt manufactured, and this is saturated with the "P. & B." water and acid proof composition. It is a perfect non-conductor, is not affected by changes of temperature, is permanently pliable and elastic, is easily applied and is claimed to have as long a life as the car itself. It is put up in rolls 60 inches wide, each roll containing enough to cover a car. The same material has been successfully used in refrigerator cars between the floors. The "P. & B." insulating papers are also used extensively in refrigerator car insulation, the Merchants' Despatch Transportation Company alone having bought over 1,500,000 square feet of it since Jan. 1, 1895. The "P. & B. Ruberoid" roofing for buildings is put up in rolls 36 inches wide, containing 216 square feet and is claimed to outlast metal roofs. Its use is advocated for round houses, train sheds, boiler houses, etc.

The Pedrick & Ayer Company, 1001 Hamilton St., Philadelphia, who manufacture the well known belt driven air compressors, advocate the use of these compressors "in series," which is accomplished by setting the automatic regulating devices on the machines at slightly different pressures, the lowest one being set at the minimum pressure desired. The others are set between this minimum, and the maximum, so that they take up their work in succession and keep at it until the maximum pressure is reached, each one stopping in turn, and remaining idle until more air is required. This is claimed to be a very decided advantage in installing an air plant. One machine can at first be installed, and when the requirements call for more air, another of the same kind can be attached to the main conveying the air to the receiver, not in any way impairing the utility of the first machine, and this process of adding machines continued as long as the demand for air increases. This plan has the advantage that should any machine become worn and require repairing, that particular machine can be disconnected and not seriously cripple the series, It is urged that even for large plants these belt compressors are economical, as they derive their power from the large shop engine, which is ordinarily more economical than the much smaller steam cylinder of a steam driven air compressor.

Spencer Miller, Engineer of the Cableway Department of the Lidgerwood Manufacturing Company, New York City, has returned from a four months' visit to Europe much improved in health and bringing with him all the American rights under the patents of the Temperly Transporter which the Lidgerwood Company will immediately place upon the market. The Transporter is a hoisting and conveying device employing a suspended beam as a trackway. The chief points in its favor are simplicity in operation, low cost and extreme flexibility. No skill whatever is required to operate the apparatus. About 300 transporters have already been made and the device has therefore passed through its experimental stage. The British Admiralty have adopted it for coaling battleships, having recently purchased nearly 100 of them. Mr. Miller also secured a contract in Paris from the new Panama Canal Company, for seven cableways which were shipped April 30, to Panama. Mr Miller has recently had a datent granted him for a novel form of scoop bucket, which has been thoroughly tested, and has proved entirely satisfactory in loan and sand. It is employed on a cableway. The bucket is lowered to the toe of the sand bank, and the carriage is run ahead so that the draw of the hoist rope is approximately parallel with the slope of the bank and the bucket is drawn up, thereby filling it. If the material be soft the bucket will fill without guidance, but in harder material the bucket has to be guided by a man following it. The bucket is then conveyed back to the place of dumping, and by virtue of lowering the bucket it is overturned and the load spilled. Mr. Miller has also had another patent granted him for a novel form of aerial dumping device.

Messrs. S. T. Wellman, J. W. Seaver and C. H. Wellman announce that they have associated themselves together under the name of the Wellman, Seaver Engineering Company, with offices in the New England Building, Cleveland, O. They expect to make specialties of the following lines of construction: Bessemer and open hearth steel plants, including the most modern furnaces and rolling mills and special electric, hydraulic and pneumatic machinery for the economical handling of material in and around the works: manufacturing and mill buildings of every description, designed with special reference to economical and substantial construction; coal handling and storage plants.

They are the owners of the Wellman Patent Rolling Open Hearth Steel Melting Furnace, which is now in operation at the works of the Illinois Steel Company, South Chicago, Ill., and at the Standard Steel Works, Burnham, Pa. They also own the Wellman patent method and machine for charging open hearth furnaces, in use at both the above works as well as in the Homestead Steel Works of the Carnegie Steel Company, and the Pencoyd Iron Works, Philadelphia, Pa, They own the exclusive right to manufacture the Seaver Patent Coal Elevator.

Complete plans, specifications, and estimates for work will be furnished in any of these lines and they are prepared to take contracts for the same, erected and in working order, or will furnish the drawings and superintend the construction for parties desiring to do their own work. They will act as Consulting Engineers for steel works desiring their services in that capacity. The well-known metallurgist chemist, Mr. Geo. W. Goetz, of 219 Thirty-Fourth Street, Milwaukee, Wis., is associated with the company.

Our Directory

OF OFFICIAL CHANGES IN MAY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Butler & Pittsburg.—F. E. House has been appointed Chief Engneer.

Boston & Maine.—Mr. P. M. Hammett has been appointed Division Master Mechanic, vice A. B. Barrett, at Boston. Mr. D. A. Smith is appointed Master Mechanic of Eastern, Western and Northern divisions, with headquarters at Somerville.

Baltimore & Ohio.—Mr. I. N. Kalbaugh has been promoted to the position of Division Superintendent of Motive Power, with headquarters at Baltimore, vice A. J. Cromwell, resigned. Master Mechanic Thomas Trezise has been transferred to the Pittsburg division with office at Pittsburg and is succeeded at Philadelphia by E. T. White.

Chicago, Peoria & St. Louis.—Mr. F. W. Huidekoper has been elected President, vice Mr. H. W. Putnam, Jr.

Chicago, Lake Shore & Eastern.—C. J. Clifford is appointed Superintendent of Motive Power, and E. B. Smith Master Car Builder, reporting to Mr. Clifford.

Chattanooga Southern.—Mr. H. A. V. Post, of New York, has been chosen President. Mr. Joseph W. Burke has retired from the position of receiver. Mr. M. F. Bonzano has been appointed General Manager, with headquarters at Chattanooga.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. W. A. Bell has been appointed Master Mechanic at Louisville, Ky. Mr. F. J. Zerbee has been appointed Master Mechanic at Wabash, Ind., vice C. H. Doebler, resigned.

Delaware, Lackawanna & Western.—Mr. Wm. S. Sloan, Second Vice-President, died on May 11.

Delaware, Susquehanna & Schuylkill.—Mr. A. J. Beltz has resigned as Master Mechanic at Drifton, Pa.

Delaware & Hudson Canal Co.—Mr. Bernard Vogle has been appointed Mechanical Engineer, with office at Green Island, N Y.

Gulf & Interstate.—W. A. Meagher has been appointed Master Mechanic, with office at Galveston.

Galveston, Houston & Henderson.—Mr. J. H. Hill has been appointed General Manager, with headquarters at Galveston, Tex.

Grand Trunk.—Mr. Adolph Butze has been appointed General Purchasing Agent. Mr. Wm. McWood, formerly Assistant Mechanical Superintendent, has been appointed Superintendent of the Car Department with headquarters at Montreal.

Interoceanic.—Mr. E. V. Sedgwick has been appointed Superintendent of Motive Power and Superintendent of Transportation.

Knoxville, Cumberland Gap & Louisville.—Mr. H. G. Fraser, Purchasing Agent, has resigned and the office is abolished.

Kansas City Belt & Kansas City Union.—Mr. E. S. Washburn has been chosen President, to succeed G. H. Nettleton, deceased.

Louisville, Evansville & St. Louis.—Purchasing Agent H. W. Matters has resigned.

Louisville, Evansville & St. Louis Consolidated.—Mr. Geo. T. Jarvis, Receiver, will also act as General Manager.

Litchfield, Carrolton & Western.—Mr. Joseph Dickson has been appointed Receiver, vice C. H. Bosworth, resigned.

Mexican Central.—Mr. W. Cockfield has been appointed Master Mechanic at San Luis.

Marshfield & Southeastern.—Mr. Chas. H. Grundy has been appointed General Manager, with headquarters at Marshfield, Wis.

Michigan Central.—Mr. E. D. Browner, Master Car Builder, has been appointed Assistant Superintendent of Motive Power, with headquarters at Detroit. Mr. J. T. Hennessy has been appointed Division Master Mechanic at Jackson. Peter Miller has been appointed Master Mechanic.

Norfolk & Virginia Beach.—Mr. O. E. Smith has been appointed Receiver.

New Orleans & Western.—Mr. Chas. E. Levy has been chosen President.

New England.—Mr. J. T. Odell has resigned the position of Second Vice-President and General Manager.

Northern Pacific Railroad.—G. W. Dickenson has been appointed General Manager, with headquarters at Tacoma, Wash. Geo. H. Earle is Secretary to Receivers, with office at St. Paul. Minn. W. L. Darling has been appointed Chief Engineer, with office at St. Paul, vice E. H. McHenry.

Ohio Southern—General Manager A. S. Dunham has resigned.

Ohio River.—Walter Layman has been appointed Master Mechanic, vice A. L. Courtrite, resigned.

Pennsylvania.—J. M. Wallis, Superintendent of Motive Power, is appointed Acting General Superintendent of Division during disability of Superintendent F. L. Sheppard.

Saginaw, Tuscola & Huron.—Sanford Keeler has resigned as General Manager. The President, William L. Webber, assumes the title of that office.

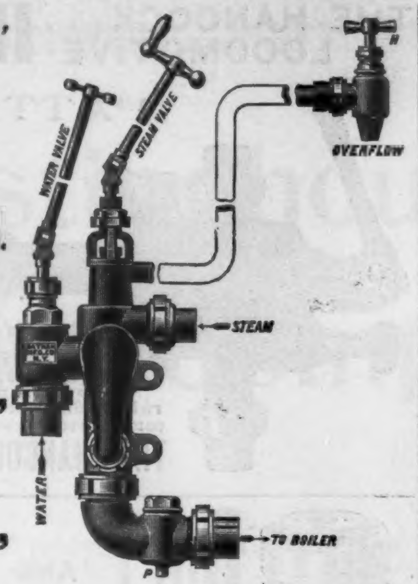
St. Louis, Belleville & Southern.—Mr. W. J. Karner, General Manager, has resigned, and the position is abolished.

St. Louis & San Francisco.—Mr. Aldace F. Walker has resigned as Receiver and Mr. John J. McCook is now sole Receiver.

Wabash.—C. H. Doebler is appointed Master Mechanic at Fort Wayne, Ind.

West Shore.—Mr. J. D. Layng, General Manager, has also been made Second Vice-President.

Employment.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STEAM
WATER
TO BOILER


596
COMPOUND


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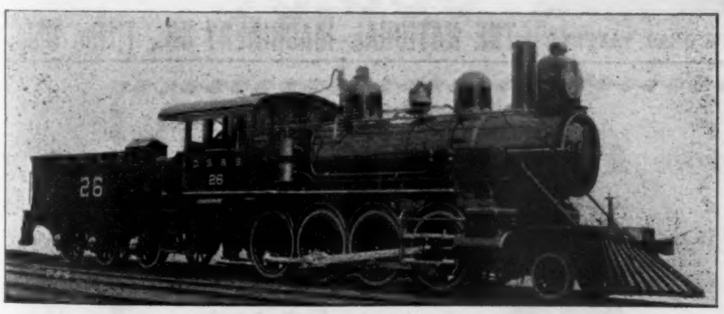
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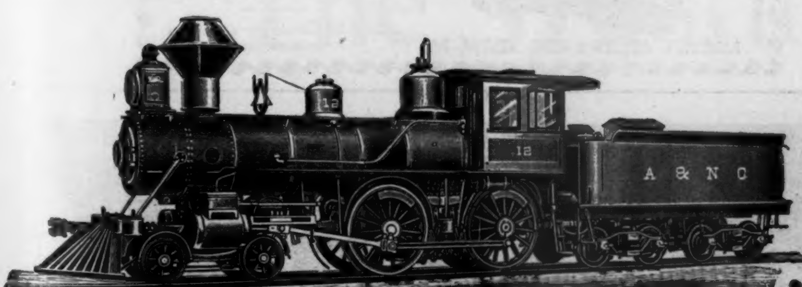
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ROOFING.

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Awarded Highest Medal and Diploma at World's Fair, Chicago.

Works perfectly with water at 120 deg., and when Inspirator is hot. No adjustment for varying steam pressures. Trials upon a great number of railroads have been invariably successful. Correspondence and competitive test solicited.

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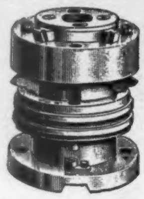
BOLT AND NUT MACHINERY.



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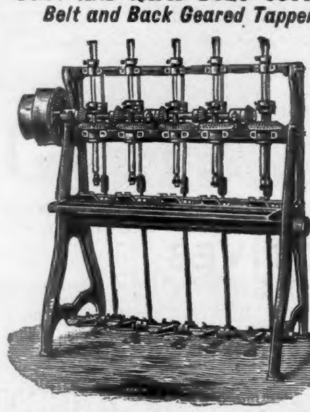
STAY AND RAPID BOLT CUTTERS.
Bolt and Back Geared Tappers.



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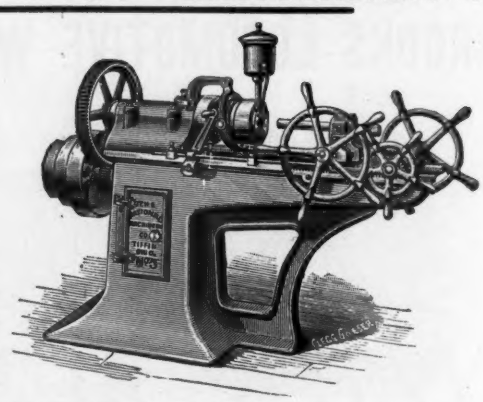

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With capacity from $\frac{3}{16}$ in. to 8 in. diam.

Bolt Pointers. Washer Machines.
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Bolt Headers. Nut Machines.
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work well in hard, cross-grained and knotty lumber,

Make Smooth Edges

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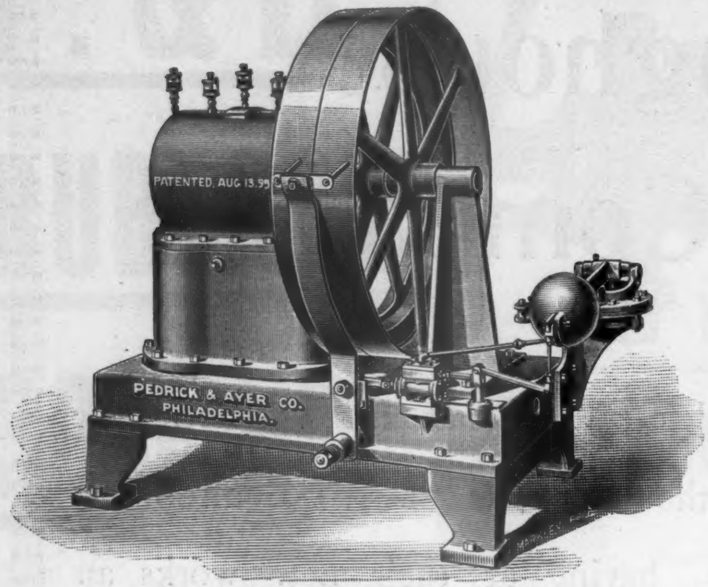
AUTOMATIC COMPOUND BELT AIR COMPRESSOR.



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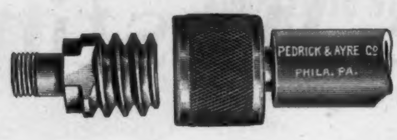

FULL SIZE.

Made in three sizes—½, ¾ and 1 inch.

A very serviceable and quick coupling. When disconnected the flow of air is stopped. A very desirable device for connecting hoists that are to be used in different places, as the load can be raised and disconnected and the hoist or other tool moved away. By having several pendant hose with these fixtures, one hoist will serve in many places.

WRITE FOR FORM NO. 13 NOVELTY.

NEW CATALOGUE JUST ISSUED. . .

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Is as necessary to the proper equipment of an engine as a monkey wrench or an oil can. It positively saves engine and valve oil, and prevents and cures hot pins and bearings.

SEND FOR SAMPLE AND TESTIMONY OF EXPERTS. JOS. DIXON CRUCIBLE CO., JERSEY CITY, N J.

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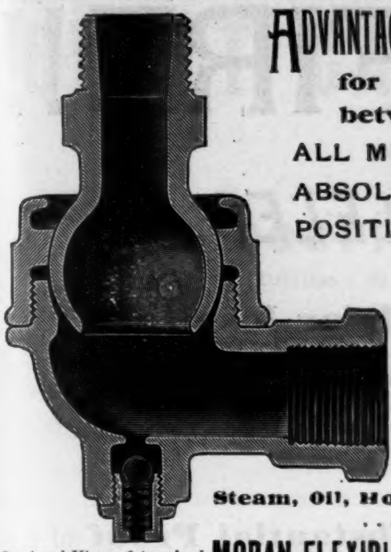

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for a Steam Heating Connection between Engine and Tender. . .

ALL METAL CONNECTION,
ABSOLUTELY FLEXIBLE,
POSITIVELY STEAM TIGHT
UNDER ANY PRESSURE,
INDESTRUCTIBLE,
SHORT OF WRECK,
NO DELAYS, NO REPAIRS,
FIRST COST IS THE ONLY COST.

Steam, Oil, Hot Ashes or Dirt does not Affect Its Life.

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Sectional View of Standard R. R. Joint, showing Automatic Relief Trap.

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Never known to fail in use on Track-joints, Bridges, Engines, Cars, Vehicles, etc.
All sizes made, both for iron and woodwork. More reliable than double nuts or copper pins.
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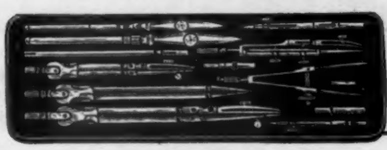

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